U.S. Department
of Transportation

**United States
Coast Guard**

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Environmental Health

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COMDTINST M6240.5
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COMMANDANT INSTRUCTION M6240.5

Subj: WATER SUPPLY AND WASTEWATER DISPOSAL MANUAL

1. PURPOSE: To provide standards and public health information for Coast Guard personnel responsible for producing, storing, monitoring, and using potable water and wastewater systems at afloat and ashore units.

2. ACTION:

   a. Area Commanders: Ensure units under their operational control carry out this Manual's provisions.

   b. District Commanders: Ensure units under their operational control carry out this Manual's provisions.

   c. Commanders of Maintenance and Logistics Commands: Ensure units under their operational control carry out this Manual's provisions and provide technical oversight and support to all units within their area of responsibility to ensure compliance with this Manual.

   d. Commanding Officers of Headquarters Units: Ensure adherence to this Manual's contents.

   e. Assistant Commandants for Directorates and Special Staff Offices at Headquarters: Perform all duties related to policy guidance and direction.

3. DIRECTIVES AFFECTED: COMDTINST M11300.2 is canceled.

4. FORMS AND REPORTS: Local reproduction is authorized of CG-5648 (6-98), Potable Water Quality Log, found in Appendix 1.A.

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5. DISCUSSION: Few environmental factors affect an individual's well-being more than an adequate supply of potable (drinkable) water. An impaired potable water system may adversely affect health, mission, and morale. Proper disposal of wastewater also is critical to CG members' and the environment's health and safety. Recent large-scale disease outbreaks involving drinking water systems and increased regulation are among the challenges inherent in water and wastewater systems and underscore the need for commands afloat and ashore to ensure compliance with this Manual.

6. SCOPE: This Manual applies to all active and reserve afloat and ashore commands.

   a. For afloat commands, water monitoring requirements found in Chapter 1 do not apply under the following condition: Vessel is moored and receives shore water from an approved municipal source which maintains a free available chlorine residual. In addition, shore water must bypass the ship's water storage tank(s).

   b. Ashore commands with CG-owned water systems, ☛ see section 2-H, are required to comply state or EPA monitoring and reporting requirements. Ashore commands who receive water from approved municipal treatment facilities are exempt from monitoring and reporting requirements if the water has a reliable disinfectant, e.g., chlorine, residual and is not further treated or stored. In addition to this Instruction, units must coordinate with their servicing Maintenance and Logistics Command, state regulating authority, and the Environmental Protection Agency to determine applicable regulations.

JOYCE M. JOHNSON
Director of Health and Safety

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CHAPTER 1: COAST GUARD WATER SUPPLY AFLOAT.

A. Introduction and Policy.

1. Purpose. This Chapter explains how to handle potable water safely and properly aboard vessels to help prevent waterborne diseases. Enclosure (1) describes the bacteriological, physical, and chemical characteristics of potable water. All personnel who fill, treat, store, distribute, and medically monitor potable water should be familiar with the current policies and regulations in this Manual.

2. Policy. Preventing waterborne disease transmission requires high-quality potable water. Potable water for shipboard use comes from the ship's distillation plant or reverse osmosis (RO) systems. Present distillation plants aboard Coast Guard cutters, designed to make the ship as self-sufficient as possible, can produce potable water from bacteriologically contaminated water if the system operator follows the specific procedures set forth in the ☛ Naval Ships' Technical Manual (NSTM), Chapter 531. The system operator must properly disinfect all distillate to be used as potable water and avoid distilling water from harbors or polluted sea water except in emergencies. Assume water is polluted when ships operate in close formation. While making potable water, do not empty bilges or sewage tanks forward of the water intakes. Operational checks of distillation plants afloat and inspecting and approving watering points ashore constitute only some of the precautions necessary to assure a safe water supply. Many points of possible contamination exist within the ship and may contribute to waterborne disease outbreaks. Therefore, regardless of the water's source, the Engineering and Medical Departments must effectively enforce standards and monitoring to assure adequate protection from subsequent contamination.

3. Responsibilities.

    a. COMDT (G-SEN). COMDT (G-SEN) designs, constructs, and maintains shipboard potable water supply and distribution systems, including treatment facilities and processes, to assure safe drinking water is available at all times.

    b. COMDT (G-WKS). COMDT (G-WKS) establishes and promulgates standards and instructions for water quality afloat and publishes appropriate instructions, notices, or other publications to reflect water quality requirements.

    c. Area Commanders. Area commanders or their designees issue necessary implementing directives to ensure each ship within the command has and enforces adequate water sanitation standards.

    d. Commanders of Maintenance and Logistics Commands. Commanders of Maintenance and Logistics Commands (MLCs) provide technical support and medical oversight for all afloat potable water systems. MLC(k) particularly emphasizes identifying and abating class-wide health hazards. Additionally, each respective MLC(k) ensures unit-level potable water systems monitoring and periodically conducts sanitary surveys.

e. Commanding Officer, Engineering Logistics Center. The Commanding Officer, Engineering Logistics Center, reviews policy and provides assistance with shipalt/boatalts and Authorized Equipment Listings development.

f. Commanding Officer. Each ship's Commanding Officer (CO) promulgates a water sanitation bill to ensure engineering and medical personnel follow procedures to receive, transfer, treat, store, distribute, and monitor potable water. Appendix 1.C. contains a Sample Potable Water Sanitation Bill.

g. Engineering Department. Reporting to the CO, the ship's Engineering Department implements the shipboard water supply system's operation and maintenance, produces an adequate amount of water, and ensures proper disinfection.

h. Medical Department Representative. The Medical Department Representative (MDR) comprehensively monitors the potable water system for health and safety, including adequacy of disinfecting procedures, collecting samples for bacteriological analysis, and monitoring required halogen residuals from the distribution system. The MDR shall notify the CO of any discrepancies he or she observes in the water distribution system. For units without assigned corpsmen, the Executive Officer/Executive Petty Officer, as the unit medical officer, must ensure these requirements are met.

4. Potable Water Sources for Coast Guard Vessels.

   a. Distillation or other approved method, e.g., reverse osmosis.

   b. Shore-to-ship delivery from an approved source.

   c. Shore-to-ship delivery from an unapproved source if an approved source does not exist; see ☛ Paragraph B.3.

   d. Ship-to-ship.

5. Water Use and Quality.

   a. Potable water, i.e., water of drinking quality, is used aboard ship for drinking, cooking, laundry, medicine, personal hygiene, and other purposes.

   b. Water quality standards include physical, chemical, and bacteriological requirements. ☛ Paragraph 1.J. discusses limited testing procedures to evaluate pertinent physical, chemical, and bacteriological quality of shipboard water.

   c. Using non-potable water in any food service space, including sculleries, is prohibited at all times unless the commanding officer obtains specific written approval to do so from the area Maintenance and Logistics Command (k) before installation. The dangers in using water polluted through cross connection from overboard sources cannot be over-emphasized. Regardless of source, cross connections between potable water and non-potable water are not permitted. Non-potable water connections are prohibited on food service equipment.

d. Non-potable water is used aboard ships in the fire mains and for general sanitary purposes. Since constant potable water conservation is required, it is impractical to use potable water for all purposes. Therefore, a ship uses sea water under certain controlled circumstances, e.g., flushing weather decks, water closets, urinals, laundry, and decontamination showers. Engineering personnel selecting a potable water source must consider water in harbors, off-shore from habitations, and when operating in fleet strength polluted and fit for use only in fire and flushing systems; do not use it for other purposes. If in an emergency a ship needs to produce water from contaminated sources, the Medical and Engineering Departments must monitor the system for halogen residual, pH, and bacteriological contamination more frequently.

6. Potable Water Usage Requirements.

a. Properly indoctrinating the crew in water conservation and reducing leaks and waste should limit potable water consumption to reasonable amounts. At times water hours may become necessary on some ships, limiting personal hygiene practices. Members may keep clean and live under sanitary conditions, even with a limited water supply, if their supervisor adequately indoctrinates and properly supervises them. If unusual conditions require drastically restricting potable water use, the minimum allowance should be two gallons per person per day for drinking and cooking.

b. Table 1.1. lists the quantities of potable water generally required aboard ship. Actual consumption varies widely, depending on vessel type, where it operates, and what work members do. If using potable water for all purposes, consumption may expend 12 to 35 gallons per person per day, though the higher figure might be considered wasteful.

Table 1.1. Recommended Amounts of Potable Water Aboard Ship

Type of Use	Gallons per Person per Day
Drinking Water	0.5-1.0
Galley and Scullery	1.5-4.0
Personal and Hygiene	5.0-20.0
Laundry	5.0-10.0
Total	12.0-35.0

B. Receipt and Transfer.

1. Preventing Contamination. When receiving or transferring water from an external source, improper filling techniques and multiple handling can contaminate potable water. If water received aboard does not have the required disinfectant residual, the system operator must add enough chlorine or bromine to produce the proper residual. If the water contains the correct disinfectant residual, the receiving ship need not disinfect. *The designated MDR or*

EDR must determine the chlorine or bromine residual immediately before the water is transferred. Authorized personnel must make or supervise all water connections between shore and ship. Potable water hoses must not be submerged in harbor water.

2. Approved Sources. Procure potable water from these approved shore facilities or other vessels:

    a. Facilities owned and/or operated by the U.S. military.

    b. Water points listed in the joint U.S. Public Health Service and Food and Drug Administration publication, *Acceptable Vessel Watering Points Interstate Conveyance Official Classification List.* The MDR should attempt to obtain this information before the ship departs from CONUS. U.S. Embassies and area MLC (kse)s also may have accurate information.

3. Doubtful Sources. The MDR and EDR should consider all water supplied by public or private unapproved systems of doubtful quality. If in doubt about water quality, he or she or a responsible officer must investigate the source and examine the water as thoroughly as possible with the means available. The MDR must then advise the CO about necessary procedures, safeguards, and disinfection. If the ship must receive suspect water, the MDR or EDR will disinfect it in accordance with ☛ Paragraph 1.D.

4. Care of Shipboard Potable Water Hoses and Equipment.

    a. Potable water hoses must not be used for any other purpose. The EDR must properly label, store, and protect them from sources of contamination at all times and routinely examine them and remove them from use if cracks develop in the lining or leaks occur. ☛ Paragraph 1.D.10. describes how to disinfect potable water hoses.

    b. Each hose connection must be fitted with a cap and keeper chain. Ship risers must be properly labeled, color-coded, and disinfected before each use.

    c. Sounding tubes for potable water tanks must have screw caps attached to keeper chains secured with a lock. On ships with sounding rods, when not in actual use the rod should remain in the tube at all times. On ships using steel tapes, the EDR must sanitize the tape before each use and use it to measure potable water only. EDRs shall store steel tapes in a clean, dry location.

5. Connection Procedures.

    a. In transferring potable water shore-to-ship and ship-to-ship these connection procedures are general guidelines; the Engineering Officer may want or need to modify these procedures due to ship configuration or operating conditions.

b. Shore-to-Ship.

(1) Remove cap and flush pierside potable water outlet for 15 to 30 seconds. Immerse outlet and rinse fitting in a solution containing 100 ppm free available chlorine for at least 2 minutes. See ☛ Paragraph 1.D.13. and Enclosure (2) on preparing chlorine solution. Flush to waste for 15 to 30 seconds.

(2) Just before connecting, deliver a clean, disinfected potable water hose to the outlet. Remove hose caps or uncouple hose ends and disinfect if necessary. Connect to pierside outlet and flush.

(3) Using the solution described in ☛ Paragraph 1.D.13., disinfect shipboard riser connections. Connect hose to the potable water shipboard riser and deliver potable water.

(4) When the transfer is completed, secure the shore water source, remove the ship connection, and then remove the shore connection. Thoroughly flush the potable water outlet and recap. Drain the potable water hose thoroughly, replace caps or couple ends, and store in the potable water hose storage locker.

c. Ship-to-Ship Transfers.

(1) Personnel trained in handling potable water must transfer potable water ship-to-ship. Normally, the supplying ship provides potable water hoses.

(2) The leading potable water hose should have the cap in place during the high-line procedure.

(3) When the receiving ship secures the potable water hose, the EDR removes the cap and disinfects the hose coupling.

(4) Both ships disinfect their respective potable water riser connections.

(5) The supplying ship connects its end and flushes the hose.

(6) When the transfer is completed, the receiving ship removes the potable water hose and replaces the caps on the receiving connection and the potable water hose.

(7) The supplying ship then retrieves, couples or caps, and properly stores the potable water hose.

C. Potable Water Storage Tanks.

1. Design and Construction. Potable water tanks' construction and location should prevent contamination of the contents. To use space optimally, on most ships potable water is stored in inner bottom tanks, other skin tanks, and peak tanks. The ship's bottom, which serves as the outer shell of inner bottom tanks, is subjected to maximum external pressure from possibly heavily polluted water and is vulnerable to leakage. The plating over the

inner bottom tanks often serves as deck spaces. Inner bottom and other skin tanks may have common bulkheads with ballast tanks, fuel tanks, or other storage spaces. These potential sources of contamination require the EDR to carefully maintain the quality of water stored in skin tanks, particularly those located in inner bottoms.

2. Introducing Non-Potable Water. Do not fill potable water tanks with ballast water unless absolutely necessary for the ship's survival. If introducing non-potable water into potable water tanks, the EDR must disconnect all tanks, lines, fittings, and pumps from the potable water system, plug or cap them, and reconnect them only after adequate disinfection.

3. Interior Coating. Contractors and authorized maintenance personnel shall paint potable water tanks' interior with an epoxy coating system complying with the ☛ Coast Guard Coatings and Color Manual, COMDTINST M10360.3A, Chapter 12, Table 19. Potable water tanks shall be coated in accordance with NSTM, Chapter 631, "Preservation of Ships In-Service (Surface Preparation and Painting)." All potable water tank coatings must be approved by and applied in accordance with National Sanitation Foundation (NSF) International Standards.

4. Vents and/or Overflow Lines.

   a. Vents and/or overflow lines provided on potable water tanks will be located to reduce the possibility of contamination. The openings must be screened with mesh 18 or more non-corrosive metal wires.

   b. Vents and/or overflow lines must not terminate in food service, medical, toilet, or other spaces that may transmit contamination or odors to the water, nor in any space where electrical or electronic equipment is located.

   c. Potable water tanks shall not vent outside the ship. *Exception*: Where such vents exist in the current fleet, an exception may be granted if vent location and ship design make shipalt impractical.

5. Manholes.

   a. Manholes' construction and location should minimize the possibility of contamination. If a manhole is located on the side of the tank, flush-type construction is acceptable. If located on the top (including the deck, if the deck forms the top of the tank), a coaming or curb rising at least one-half (½) inch above the top of the tank must be provided and the manhole cover must extend to the outer edge of the curb or flange.

   b. The cover must have an intact gasket and a device to secure it in place. Normally, manholes not exposed to the weather decks are fitted with a flush manhole cover or a raised, bolted-plate cover. The latter is preferable for potable water tanks.

6. Measuring the Water Level.

   a. There are several methods to measure water in tanks, including automatic level gauges, petcocks, and sounding tubes. Many ships have more than one system.

   b. On ships with sounding rods, when not in actual use the rod should remain in the tube at all times.

   c. On ships using steel tapes, the EDR must sanitize the tapes before each use; store them in a clean, dry location; and use them only to measure potable water.

   d. Sanitize sounding tapes by soaking the entire tape apparatus in a solution of 100 ppm chlorine for two minutes.

7. Filling Lines.

   a. Potable water lines must never cross-connect to any non-potable line or system. If a common line is used to load and distribute potable water to non-potable tanks, an air gap must deliver the non-potable water to non-potable tanks.

   b. Filling lines that have a common piping arrangement to direct potable water from an approved source to non-potable water systems by means of valves or interchangeable pipe fittings are not acceptable.

   c. Filling connections (hose valves) must be clearly labeled and color-coded to comply with ☛ NSTM, Chapter 505, and the Coast Guard Coatings and Color Manual, COMDTINST M10360.3A. Screw caps attached with keeper chains must secure filling connections.

   d. Filling connection hose valves must have the potable water receiving connection at least 18 inches above the deck and turned down to protect it from contamination.

8. Potable Water Piping.

   a. Potable water tanks are usually installed low in the ship. The EDR must pay careful attention to the piping installed in the bilge area, particularly piping on the suction side of the potable water pumps where leakage could contaminate the potable water system.

   b. When piping potable water through non-potable tanks and non-potable liquid through potable water tanks, a sloped, self-draining pipe tunnel must surround the pipe.

c. An adequate air gap must separate any potable water outlet and a non-potable water system, fixture, or machine; permanent direct connections must be installed only with approved back flow prevention devices; see ☛ Paragraph 1.H.3.

d. All potable water pumps should be airtight and have no cross-connections. Never use non-potable water to prime pumps or maintain packing gland seals. The EDR must disinfect pumps dismantled for repair after reassembly and before returning them to service.

e. Do not connect charcoal-impregnated or other filters to potable water piping outlets. Some of these devices remove required trace halogen (chlorine or bromine) residual from the potable water and defeat the purpose of residual halogen protection. The EDR must remove any filtration equipment already installed.

f. Paint potable water piping, including valve bodies, to match the surrounding areas to comply with the ☛ Coast Guard Coatings and Color Manual, COMDTINST M10360.3A (series), Chapters 10-A-23 and 12, Table 16.

g. If feasible, identify potable water piping to indicate contents, destination, and flow direction to comply with the ☛ Coast Guard Coatings and Color Manual, Chapter 10-A-23.a. through h.

h. Paint potable water valve handles and levers dark blue (Fed. Std. 595, Color Number 15044) to comply with the ☛ Coast Guard Coatings and Color Manual, Chapters 10-15-A-23.g. and 12, Table 17.

i. Do not paint potable water valve packing glands, valve stems, threads, and other similar working surfaces.

9. Repairs.

a. If any accidental or intentional break occurs in the potable water system, or a potable water tank is entered for any reason, the Engineering Department must disinfect all involved tanks, parts, and lines before returning the system to use. The EDR must notify the MDR of the break or entry and the Department's disinfection procedure.

b. The Engineering Department shall not repair potable water piping or butter up flanged joints with white lead or other lead-containing substances or putty because these are toxic. Sealants for use in potable water piping systems must meet NSF International Standards. Confirm sealants by contacting the nearest MLC.

10. Potable Water Tank Coatings. To avoid difficulties with taste, odors, and the danger of contamination by toxic chemicals, use only those tank lining materials specified in ☛ NSTM, Chapter 631, and NSF International Standards. Follow proper application

methods, including the coat's thickness, touch-up material, ventilation, temperature, humidity, and curing time, etc., or taste and odors may result.

11. Labeling Potable Water Systems.

   a. Clearly label potable water sounding tubes with an identification plate. Color-code the sounding tube cover dark blue to comply with the ☛ Coast Guard Coatings and Color Manual. Ships using steel tapes to sound potable water tanks must color-code in dark blue, label, or otherwise identify the tape handle POTABLE WATER USE ONLY.

   b. Conspicuously designate valves that receive or supply potable water by a warning plate inscribed POTABLE WATER ONLY in 1-inch-high letters.

   c. Hoses receiving and discharging potable water shall be constructed of material meeting NSF International Standards and approved for that purpose. Potable water hoses must be labeled POTABLE WATER ONLY approximately every 10 feet and the end couplings painted dark blue. An approved potable water hose (NSN: 4710-01-248-8828) is available through the Federal stock system.

   d. Potable water hose storage lockers must be identified and labeled POTABLE WATER HOSE AND FITTINGS STORAGE ONLY in letters at least one-half (½)-inch high.

   e. Potable water lines passing through any given space must be appropriately labeled to indicate the type of service and an arrow to indicate flow direction.

12. Potable Water Hose Lockers.

   a. When not in use, potable water hoses must be coupled or capped and stored in designated self-draining, smooth, non-toxic, corrosion-resistant, easily cleaned, vermin-proof, locked lockers used for no other purpose and elevated at least 18 inches off the deck when located on weather decks.

   b. Printed instructions outlining step-by-step methods to disinfect potable water hoses and risers must be posted conspicuously inside the hose storage locker.

   c. Where it is not practical to use designated lockers due to space limitations, the EO must ensure potable water hoses are stored separately from other hoses in a secure and sanitary location.

D. Disinfecting Potable Water Supplies.

1. Purpose. Disinfecting water destroys pathogenic organisms. Maintaining a halogen residual (either chlorine or bromine) is the usual method of guarding against sanitary defects or accidents that may occur in producing, handling, storing, and distributing

potable water. The residual's presence provides a safety factor but does not correct unsanitary practices or conditions. The absence of a free available chlorine (FAC) or total bromine residual (TBR) in the ship's potable water may indicate contamination. In pure water, free halogen residual concentrations as high as 2.0 ppm usually do not cause objectionable tastes and odors, but if certain organic substances are present, very small concentrations combined with chlorine or bromine can produce undesirable tastes or odors, though these do not affect the safety of water if the halogen residual (FAC or TBR) is at least 0.2 ppm.

2. Procedure. Disinfect shipboard water by adding sufficient chlorine or bromine compound to produce at least 0.2 ppm FAC or TBR after 30 minutes' contact time. The amount of chlorine or bromine required to do so can vary widely because of halogen demand, the amount of chlorine or bromine used in reactions with substances present in the water. All water—even distilled water produced by the evaporators—has some halogen demand.

3. Disinfectants (Halogens).

   a. Chlorine is available for shipboard use as granular solid calcium hypochlorite (HTH—65 to 70% available chlorine) or liquid sodium hypochlorite in varying strengths (common household bleach is a 5.25% sodium hypochlorite solution). Calcium hypochlorite (HTH) is used most frequently because of its relatively long shelf life and smaller space requirements. However, calcium hypochlorite presents a potential hazard because it is corrosive and chemically active in nature. This material is dangerous and requires special storage precautions. Handle and stow it to comply with ☛ NSTM, Chapter 670. Contact between calcium hypochlorite and oxidizable material may result in spontaneous combustion. Because calcium and sodium hypochlorite lose strength gradually with age and more rapidly when opened and stored in hot spaces, procure in 6-ounce plastic containers.

   b. The Engineering Department must stow its issued stock of ready-to-use, 6-ounce bottles in a locked box, preferably metal, such as a first-aid locker, mounted on a bulkhead, preferably in Department office space. Never install the box in a machinery space, flammable liquids storeroom, berthing space, storeroom, or the oil and water test laboratory areas. Department personnel shall drill vent holes, e.g., three ¼-inch holes, in the bottom of the box to allow the release of any chlorine products. The Department shall maintain a maximum of a seven-day supply of ready-to-use stock at any time.

   c. Engineering Department personnel must store calcium hypochlorite stocks in labeled, ventilated lockers or bins located where they are not subject to condensation or water accumulation. The maximum temperature must not exceed 100° F (37.8° C) under normal operating conditions and the lockers and bins must be located at least five (5) feet distant from any heat source or surface that may exceed 140° F (60° C). The bins must not be located adjacent to a magazine or in a storage area for paints, oils, grease, or other combustible organic materials. An individual locker or bin may contain a maximum of 48 6-ounce bottles. Supervisors will issue bottles only to personnel designated by the MDR or Engineering Officer.

d. Label all lockers, bins, and enclosures containing calcium hypochlorite with red letters on a white background, HAZARDOUS MATERIAL: CALCIUM HYPOCHLORITE.

e. Bromine comes in a slightly corrosive bromine-impregnated resin cartridge requiring proper handling and storage procedures. Store bromine cartridges in a clean, dry, ventilated storeroom. Bromine storage lockers require a hazardous warning plate described in NSTM, Chapter 533, Figure 6. Bromine cartridges have a shelf life of two years from the manufacturing date; Engineering personnel can use cartridges exceeding that shelf life, but the cartridges may not be as effective.

4. Mechanical Treatments. At present, two halogen compounds, chlorine and bromine, are the only approved methods to disinfect shipboard potable water. Mechanical treatment methods are preferable to batch treatment procedures, which are less reliable, require more time and effort, and are generally less effective; a batch treatment with bromine does not exist.

5. Chlorinators. Coast Guard vessels use several types of chlorinators, which may be installed in the distilling plant, distillate line, the shore fill line, or jointly on the distillate and shore fill lines.

a. The distillate line generally has an electric motor-driven chlorinator with controls that activate the chlorinator in conjunction with the distillate pump motor and water flow past the chlorinator.

b. The shore fill line generally has either a hydraulically actuated or electric motor-driven chlorinator. Both units inject hypochlorite solution into the water system proportionally to the flow of water through a meter.

c. A fill line chlorinator may serve the distillate line and the fill line if the distilling plant is large enough to permit sufficient flow through the unit. This type of installation generally has either a hydraulically actuated or electric motor-driven chlorinator.

6. Brominators. Brominator treatment installations are of two types, one used on the distillate discharge line and the other used to recirculate water in the potable water tanks during treatment.

a. Distillate discharge line brominators—called automatic proportioning brominators—are capable of feeding bromine at two feed rates. Dual-feed rate automatic proportioning brominators feed a fixed rate of either 0.7 ppm total bromine residual (TBR) or 2.7 TBR at the high feed rate, the latter used if the ship is distilling water from a contaminated source.

b. The recirculation brominator system treats water in potable water tanks by recirculating it from a potable water tank through the brominator and back to the same tank. This treatment offers flexibility in recirculating and brominating shipboard water from external sources or increasing bromine levels if necessary. As the selected tank's water recirculates, a portion of the recirculated water is automatically diverted to flow through the bromine cartridge. A timing device limits flow through the cartridge to achieve the required bromine feed into the selected tank. After a pre-set period of time based on individual tank volume and water temperature, the timing device terminates the bromine feed into the water. Water continues to recirculate for an additional pre-calculated duration to completely, evenly disperse bromine through the tank. The system operator also can pre-set this recirculation unit to deliver 0.7 ppm bromine to recirculating water. A sampling tap is present to test the bromine residual after recirculation. If the first process does not achieve the desired bromine level, the system operator can reset the timer and recirculate the water until it reaches the desired TBR level; however, efforts to achieve 2.0 or more ppm bromine levels may not be practical due to the length of time required. It may be more convenient to use batch chlorination procedures to rapidly chlorinate the water supply, particularly if the water is contaminated or requires superhalogenation.

7. Batch Chlorination.

a. Engineering personnel can use "batch chlorination" disinfection methods if mechanical treatment methods are not available. However, this is the least desirable method to disinfect potable water because it may result in over-chlorination due to an inability to properly mix the water and hypochlorite solution. Engineering personnel must determine the proper chemical dosage for the volume of water to be disinfected; see the ☛ Chlorine Dosage Calculator, Enclosure (2). If using 65 to 70% calcium hypochlorite, dissolve the calculated amount in a non-glass container of warm water (80° to 100° F) and allow the suspended matter to settle out, discarding the remaining sediment. When the tank is about one-quarter full, add one gallon of potable water to flush the sounding tube and introduce the clear fluid (supernatant) into the sounding tube or fill connection. Never attempt to chlorinate by adding the solution to the brominator cartridge container. The stirring action of the incoming water as the tank fills generally mixes the water and chlorine solution sufficiently; the ship's motion and recirculation also mix the water slightly. If introducing the chlorine solution into a full tank, recirculating through a pump is the only way to mix adequately. If using pumps that are not an integral part of the potable water system, disinfect them first.

b. The system operator should sample the water and test it for an FAC residual 30 minutes or more after the tank is filled or mixing is completed. If the tank has no sampling petcocks, for sampling purposes the system operator may use a potable water outlet in the distribution system nearest the tank. If the FAC residual is less than required, the system operator must add more chlorine, mix it into the water and, after 30 minutes, determine the FAC residual again. One ounce of full-strength calcium hypochlorite added to 5,000 gallons of water is the approximate dose to achieve a 1.0 ppm initial chlorine concentration. Exposure to air rapidly reduces the amount of active chlorine in 65 to 70% calcium hypochlorite, so use all the contents as soon as possible after opening the container. This "rule of thumb"—one ounce per 5,000 gallons—is helpful in calculating dosages for batch chlorination and is a suggested starting point only; the actual required amount depends on temperature, pH, and the water's chlorine demand. **NEVER** remove the manhole cover to batch-chlorinate a tank; introduce the chlorine into the tank through sounding tubes or air vents or by other methods.

c. Chlorination or bromination procedures are not adequate until the water contains the required FAC or TBR after 30 minutes. ☛ Paragraph 1.D.13. lists required residuals.

d. Ships with bromine systems may add bromine to previously chlorinated water with no harmful effect.

8. Halogen Requirements.

a. To assure safe potable water throughout the ship's distribution system, all parts of that system must contain a measurable trace halogen residual. Sometimes this standard is difficult to achieve in certain sections of the ship, particularly in the O level with its reduced usage of potable water. In the absence of bacteriological contaminants, a lack of measurable residual in less-used outlets should not be a matter of concern, but requires close bacteriological monitoring.

b. All water delivered to the tanks, whether from approved sources or produced on board, must be chlorinated or brominated to provide at least 0.2 ppm halogen residual (FAC or TBR) after 30 minutes' contact time.

c. If obtaining potable water from approved sources that use chloramines to disinfect, the Engineering Officer shall contact the area MLC (kse) about required testing, treatment, and monitoring. As is FAC, chloramines are a chlorine residual, albeit slower and less effective than FAC. Produced by combining chlorine and ammonia, chloramines are bactericides but their disinfection rate is 60 to 100 times slower than FAC. To measure chloramine levels, follow the procedures for testing combined residual chlorine using the DPD test kit.

d. The system operator must chlorinate or brominate water received from an unapproved source, one of doubtful quality, or an area where amoebiasis or infectious hepatitis is endemic to achieve between 2.0 to 5.0 ppm halogen residual (FAC or TBR) in the tanks after 30 minutes. In these instances, if the ship's brominator cannot achieve a TBR of 2.0 ppm, the system operator must chlorinate the water by the batch method to at least 2.0 ppm FAC after 30 minutes' contact time. Once the water in the tank meets this criterion, it is safe to use.

9. Disinfecting Potable Water Tanks and Systems.

a. The two types of disinfection procedures are mechanical cleaning combined with chemical disinfection and chemical disinfection alone.

b. Mechanically cleaning tanks includes all measures necessary to remove existing foreign materials, rust, and other substances from the tanks.

c. Contractors or authorized maintenance personnel will mechanically clean and chemically disinfect the tanks when their condition has deteriorated to the point at which chlorine demand has increased significantly and bacteriological evidence indicates the tank has become grossly polluted. After mechanically cleaning any tank, workers will chemically disinfect it. Perform mechanical cleaning and chemical disinfection under these conditions:

(1) New tanks, including those on new vessels;

(2) Rehabilitated or repaired tanks;

(3) Sludge or rust accumulation seriously impairs the quality of water delivered.

(4) Tanks have been loaded with non-potable ballast water.

(5) Voids or tanks converted from non-potable water to potable water tanks.

CAUTION: Tanks are confined spaces and entry could immediately endanger life or health. Always ensure a gas-free engineer or competent person has evaluated and approved entry and work procedures before workers enter.

d. Butter-worthing—mechanical cleaning at sea with sea water—is permitted, but always follow it with chemical disinfection. Mechanical cleaning, especially if using sea water, promotes rust in the tanks and is laborious and time-consuming.

e. Chemical disinfection is required under these conditions:

(1) Tanks show evidence of continued bacteriological contamination after normal disinfecting procedures;

(2) Pipelines, valves, pumps, etc., have been dismantled, repaired, or replaced.

(3) Tanks have been entered.

(4) New or contaminated hoses.

f. To chemically disinfect a system, engineering or maintenance personnel must take these steps:

(1) Introduce enough chemical into the tanks to produce at least 100 ppm FAC; see the Chlorine Dosage Calculator in ☛ Enclosure (2).

(2) Fill tank with potable water.

(3) Using the ship's pumps, drain chlorinated water from each outlet to ensure this treatment reaches all contaminated system components (pumps, valves, lines and hoses).

(4) After four hours' contact time in the tanks and system, the FAC residual must be at least 50 ppm; test the water once an hour to ensure it maintains the proper FAC. If ever during the four hours the FAC residual falls below 50 ppm, add chlorine to bring the residual to 100 ppm and start the four-hour contact time again.

(5) Pump potable water from the lowest opening in the tanks through the contaminated lines, pumps, and valves, and return it to the tank or dispose.

g. If chemically disinfecting two or more tanks, re-use the highly chlorinated water from the first tank to disinfect other polluted tanks; the system operator may need to add more chlorine to maintain desired residual until all have been treated.

h. If it is impractical to disinfect a potable water tank as described above, follow this procedure:

(1) Thoroughly clean and rinse the tank.

(2) Swab all tank surfaces with a solution of 100 ppm chlorine or pump the solution through hoses so it reaches all tank surfaces. Use adequate personal protective measures, including appropriate respirators as recommended by the gas-free engineer; see ☛ caution below.

(3) Flush all water used for super-chlorination from the tank.

(4) Rinse with potable water, and the tank is ready for use. Engineering personnel must maintain an FAC residual of at least 2.0 ppm in water transported and stored in these tanks.

CAUTION: Chlorine at 100 ppm may generate vapors dangerous to persons working in these tanks. The gas-free engineer must authorize entry into these tanks. See
☛ NSTM, Volume 3, Chapter 74.

10. <u>Disinfecting Potable Water Hoses and Appurtenances</u>

a. Disinfect potable water hoses by filling with a solution containing at least 100 ppm FAC. The solution must contact the entire internal surface of the hose for at least two minutes. Flush the hose with potable water 30 to 60 seconds; then use.

b. Before connecting the potable water to either the ship riser or shore source, disinfect the fittings' interior by at least two minutes' contact with a solution of 100 ppm FAC. Flush the shore water source to waste 15 to 30 seconds before hooking up the ship's water hose.

c. Disinfect both sounding tapes and rods by wiping with a 100 ppm chlorine solution.

11. Disinfecting Water for Emergency Drinking and Cooking.

a. If potable water is not available during an emergency, it may be necessary to treat poor-quality water for drinking and cooking. Such water should be clean and as free of turbidity as possible. Before using this water, chlorinate initially to at least 5.0 ppm FAC with a final residual of at least 2.0 ppm FAC after a 30-minute contact time to make sure the water is safe. Another way to make safe water is to boil it at a rolling boil for two minutes; however, it is impractical to boil adequate quantities of water.

b. If the water is excessively contaminated or turbid, consider using canned or other emergency drinking water sources or water purification tablets (NSN: 6850-00-985-7166).

12. Chlorine Dosage Calculator.

a. Theory of Operation. This chart, Enclosure (2), contains the chlorination "dosage rate." The water quality, e.g., the organic and inorganic materials present, will affect the final chlorine residual. "Chlorine demand" is the amount of chlorine required to react with and be absorbed by these materials. The absorbed or neutralized chlorine has no disinfectant value, so it is necessary to add enough chlorine (adequate dosage rate) to satisfy the chlorine demand and still provide FAC, the active disinfecting agent, to produce the chlorine reading, determined with the colorimetric test kit. A dosage rate of roughly 1 ounce of 65 to 70% calcium hypochlorite per 5,000 gallons yields 1.0 ppm. Due to chlorine demand, this dosage rate probably will produce a FAC residual of about 0.2 ppm after a 30-minute contact period.

b. Instructions for Use.

(1) Select desired parts per million. Determine the strength of sodium or calcium hypochlorite to be used. Compute number of gallons to be chlorinated. Read across to obtain quantity of material to be used.

(2) The 5% and 10% listings are liquid sodium hypochlorite; thus, the measurements are expressed as volume.

(3) The 65 to 70% listings are granular calcium hypochlorite; thus, the measurements are expressed as weight.

c. In determining the volume of a hose for disinfecting purposes, a standard 2½" water hose has a volume of 0.25 gallons per foot. ☛ "Water Supply Ashore," Chapter 2, Table 2.1, lists volumes for other hose sizes.

13. Required Halogen Residuals. This chart lists the required halogen residuals for various disinfection needs:

Dosage and Time Requirements		
	Chlorination (FAC)	Bromination (TBR)
Treatment Required	Dose and Time	Dose and Time
1. Minimum residual required for potable water produced on board or obtained from an approved source	0.2 ppm after 30 minutes in tanks	
2. Water from unapproved source or area where amebiasis or hepatitis is endemic.	2.0 ppm after 30 minutes in tanks	
3. Water in potable water distribution system.	Trace readings throughout. Measurable trace halogen residuals—detectable color changes noted when using a DPD comparator—are acceptable provided bacteriological test results are consistently negative.	
4. Disinfecting tanks and system.	100 ppm initially; 50 ppm after 4 hours	Not applicable
5. Disinfecting hoses, couplings, and water connections before connecting to potable water system.	100 ppm for 2 minutes	Not applicable
6. Scrubbing interior of contaminated tanks when potable water is scarce.	100 ppm	Not applicable
7. Emergency water supply for drinking and cooking.	5.0 ppm after 30 minutes	Not applicable
8. Fuel cargo tanks converted to carry potable cargo water.	2.0 ppm at destination	Not applicable

E. Ballast and Cargo Water.

1. Policy. Engineering personnel must disconnect and seal off at the tanks any potable water tanks and pipelines that will be filled with any non-potable liquid for ballast or other emergency purposes. Do not reconnect until the contaminated tank, piping, and fittings have been properly cleaned and disinfected. Disinfect this system as described in ☛ Paragraph 1.D.13. Do not use water from these tanks for drinking or cooking until it has been adequately disinfected and a bacteriological analysis is negative. If these tests are positive, repeat the disinfection process as often as needed until the bacteriological analysis is negative before placing the system in service.

2. Cargo Water. Follow these provisions when handling water transported in bladders and/or temporary storage vessels:

   a. All containers used to treat, store, transport, and distribute potable water must be clean and clearly labeled POTABLE WATER.

   b. Interior surfaces must be constructed of smooth, non-toxic, non-corrosive materials and free from rust and chips. Containers must have tight-fitting caps, lids, or closures that close securely. Any gaskets must be easily cleaned.

   c. Do not use potable water containers for any other purpose. Inspect, clean, and disinfect whenever necessary, but at least monthly.

   d. Mechanically clean and chemically disinfect under any of these circumstances:

      (1) Before placing a new container or system into service.

      (2) Before using containers or systems that have accumulated rust, scale, or sludge.

      (3) There is evidence of human, animal, or chemical contamination.

      (4) The system components have been dismantled or replaced for repair or alteration.

   e. Follow these procedures to mechanically clean and chemically disinfect:

      (1) Drain the container or system.

      (2) Scrub the interior surfaces, including all gaskets, lids, and spigot openings, with a soft brush and detergent solution.

      (3) If available, use high-pressure water or steam to rinse the container.

      (4) Open all valves, lids, taps, or spigots and allow the detergent solution to drain out through the system.

      (5) Rinse all surfaces thoroughly, several times if necessary, with potable water.

      (6) Super-chlorinate the container or system as described in ☛ Paragraph 1.D.9.

   f. Water vessels will deliver potable water with a halogen residual of at least 0.2 ppm from an approved watering source to receiving ships. If the halogen residual is less than 0.2 ppm, add sufficient chlorine or bromine to ensure at least 0.2 ppm halogen residual is present in the water when delivered.

   g. Disinfect water received from an unapproved source to at least 2.0 ppm after 30 minutes' contact time; thereafter, maintain the residual at or above 0.2 ppm.

3. Receiving Cargo or Transferred Water.

    a. The receiving ship's MDR must test the water's halogen residual before loading. The received water should have a minimum residual of 0.2 ppm.

    b. If the water does not contain a halogen residual of at least 0.2 ppm, the Engineering Department must treat the received water before using it in the distribution system.

    c. If the water source is unapproved, the MDR must bacteriologically test the water before and after adequate disinfection to 2.0 ppm to ensure bacteriological quality.

    d. The MDR must complete the Potable Water Quality Log, CG-5648, to adequately document sources, halogen residual, bacteriological examinations, and recommendations; Appendix 1.A. shows a locally reproducible sample Log.

    e. If the water transferred to the ship does not contain the required halogen residual, the MDR should officially notify the area MLC (kse).

F. Emergency Water Supplies.

1. Battle Dressing Stations.

    a. To provide an alternate water source in emergency situations some ships' battle dressing stations are equipped with built-in, sufficiently large, gravity-flow, potable water storage tanks isolated from the main potable water system. A piping diagram is provided for each tank with appropriate instructions for filling and emptying.

    b. Maintenance.

        (1) Once each quarter the Engineering Department must drain and refill all potable water emergency storage tanks with potable water containing 0.2 ppm halogen residual.

        (2) At least every three years, the Engineering Department must open all emergency potable water tanks, disinfect them, and inspect them for evidence of sludge or foreign material. Based on the results of this visual inspection, Department personnel may have to thoroughly clean the tank's interior. A new gasket may be required each time the tank is opened for inspection; replace the gasket if any cracking is visible.

        (3) After filling and monthly thereafter the MDR must bacteriologically analyze water from each tank. If this analysis indicates a tank is contaminated, the Engineering Department must open, inspect, clean if necessary, and disinfect it.

(4) Routine halogen residual tests are not required.

2. Emergency Potable Water, 5-Gallon Containers.

a. Some small ships store emergency potable water supplies in 5-gallon containers because they lack an emergency tank in battle dressing stations. Fill these containers with water produced on board or from approved shore facilities. This storage is acceptable if the containers have been properly cleaned and disinfected before filling.

b. Currently one heavy-gauge plastic, 5-gallon potable water storage container is available in the stock system. ***NEVER*** use 5-gallon containers previously used to store gasoline or other petroleum products as emergency potable water containers aboard ship.

c. Examining Water Containers Before Disinfecting and Filling.

(1) First, carefully examine containers to ensure they have been used only to store potable water and for no other purpose. Each container's exterior surface must carry the inscription POTABLE WATER ONLY in letters at least 1 inch high either embossed or painted on it.

(2) Then physically inspect each container for these conditions:

(a) Evidence of open seams or surface breaks.

(b) Any evidence of dirt, grit, organic matter, or other substance embedded in the container's interior surface.

(c) Carefully inspect the cap to ensure it seats properly to the sealing surface.

(d) Ensure the gasket is properly fitted and structurally intact. If the gasket has deteriorated, replace it before using the container.

(e) If present, ensure the locking lever works properly by engaging the seat or lock ring cam lugs.

(f) Ensure the carrying handles are properly attached and in good repair.

d. Wash manually in warm water (110° to 125° F), using the recommended amount of approved dishwashing detergent *only* and a suitable long-handled, slender brush. Then thoroughly rinse with potable water. Use only approved dishwashing detergent to clean emergency water containers.

e. Disinfect all interior surfaces by exposing them to 100 ppm FAC solution for at least two minutes.

f. Potable water used to fill emergency containers must contain a 0.2 ppm FAC or TBR.

g. Label each can with fill date and potable water source.

h. Store the 5-gallon containers in a clean, dry place in the immediate vicinity of their anticipated use, e.g., a battle dressing station without emergency potable water tanks.

i. Every three months Engineering personnel must empty, flush, and refill these containers with potable water containing a 0.2 ppm FAC or TBR.

j. Halogen residual and bacteriological tests are not required.

3. Boats, Rafts and Battle Stations.

a. The MDR must inspect canned drinking water stored for emergency use in boats, rafts, battle stations, battle dressing stations, or storerooms as indicated below. However, these inspections need not include water supplies in encapsulated rafts if the raft is opened and repacked at selected shore facilities.

b. At least quarterly the MDR must inspect drinking water can exteriors for rust, dents, and general appearance to ensure the water is properly stored and safe to consume. Do not use cans dented across the ends or side seams or crinkled to a point or edge. Rusted cans may be used if the rust does not penetrate the can; rust that can be wiped off is not penetrating. Replace any containers showing evidence of leakage or severe distortion.

G. Evaluating Taste or Odor Problems in Shipboard Potable Water.

1. General. Though taste and odor problems are primarily aesthetic, they are worrisome aboard ship because they impair members' morale. Most people are extremely sensitive to taste and poor-tasting water will affect coffee and other beverages. Shipboard water treatment processes do not easily control taste or odor problems that develop. Generally, water produced by the ship's distillation plant is good quality and the least likely source of problems. As a mobile environment, a ship must rely on various water sources, e.g., shore, barges, or other ships. A ship's variety of piping systems, if not isolated, can cause severe problems. The uniqueness of the shipboard environment, the complexity of piping systems, and multiple water sources individually or jointly may be factors in the source of taste or odor problems aboard ship.

2. Causes of Taste or Odor in Potable Water. These conditions or factors may contaminate potable water, resulting in severe taste or odor problems aboard ship. Consider each individual situation as a possible source of taste or odor problems.

a. Cross-connections with non-potable systems.

b. Leaks in common bulkheads between potable water and fuel tanks, ballast tanks, bilges, and wastewater tanks.

c. Leaks in non-potable piping through water tanks.

d. Improper disposal of chemicals or liquids through potable water-sounding tubes.

e. Using potable water hoses for non-potable liquids.

f. Water stored in tanks an excessively long time.

g. Improper distillation processes in harbors contaminated with industrial or biological wastes.

h. Inadequate disinfection procedures resulting in development of chloramines.

i. Transfer of water with taste or odor problems from shore facilities or barges.

j. Improperly cleaned or disinfected potable water tanks used for ballast or other liquids.

k. Deteriorated or improperly applied tank coatings.

l. Distilling plants producing potable water while stripping JP-5 tanks, pumping oily bilges overboard forward of the distilling plant feed pumps' suction, or in close proximity to other ships.

3. Indicators of Taste or Odor Problems.

a. The MDR is directly responsible for monitoring the potable water system. Usually he or she performs this function by daily determining chlorine or bromine residuals in representative areas of the ship and performing weekly bacteriological analyses of the potable water. These tests, as well as complaints from the crew, can be very helpful in identifying and locating the source of taste or odor problems.

(1) Crew Complaints. If the potable water supply has taste or odor problems, Medical and Engineering personnel usually are the first to know, since the crew will very helpfully draw their notice to the problems. These initial complaints can provide important data, particularly if the complaints are confined to a segment of the crew, a specific location, or a specific time pattern. An MDR or EDR can pinpoint all these factors to a particular tank in use, its disinfection processes, and its associated piping system. Each item of information is important when evaluating taste and odor problems.

(2) Bacteriological Analysis. If the taste or odor problem's cause or source is due to biological growth in the tanks, the Colilert or Membrane Filter Technique may not necessarily assist in identifying the biological source. The MDR tests to identify bacteriological contamination by coliform organisms that indicate fecal contamination. The culture medium used in testing restricts the growth of many organisms that may contribute to taste or odor problems. Therefore, although bacteriological tests of the ship's water supply consistently may be negative, the source of taste or odor problems nonetheless could result from biological growth in the tanks. Other testing methods will determine the source of the problem.

(3) Halogen (Chlorine or Bromine) Residuals. Perhaps the most effective, practical tool in evaluating problems associated with a water system is the halogen test for

chlorine or bromine. It can be performed rapidly and provides a great deal of information about conditions in the potable water tanks and distribution system. Presuming water received from an external source or produced within the ship has been disinfected properly, the tanks contain an initial amount of chlorine or bromine. As the tanks are placed on line, the chlorine or bromine residual should be detectable at points throughout the distribution system. The MDR can measure halogen residuals at the tank and various points in the distribution system to identity the loss of disinfectant in the system and possible sources of problems.

b. Disinfectants, including chlorine and bromine, react with virtually any substance in water; this process may neutralize them. The water supply's halogen demand varies with the amount of interfering or neutralizing substances present, since they reduce the initial supply of chlorine or bromine added to the water. This complex problem can be simplified for medical surveillance purposes as follows: if the proper amount of chlorine or bromine was added to the tanks and no halogen residual is present or it disappeared somewhere in the distribution system, this indicates some substance has used or neutralized the system's disinfectant. The tanks' or potable water system's lack of ability to maintain a halogen residual indicates the chlorine or bromine is reacting with some substance that may cause the taste or odor problem. While the causes of taste or odor problems vary widely, a systematic approach may resolve the problem or at least provide helpful initial data for more experienced investigators.

4. Initially Evaluating Taste or Odor Problems. These statements and questions represent a standardized approach to complaints received or experienced with taste or odor in the potable water supply. Medical and Engineering Department personnel may identify the source of the problem by evaluating these questions. If this evaluation does not reveal the source, the Medical and Engineering Department will have conducted a great deal of the initial evaluation and provide a baseline of information for personnel from MLC (kse) or other organizations tasked to evaluate the problem.

a. When was the problem first noticed or initial complaints received? This date and time may correlate to a particular tank, section of the piping system, or repairs and maintenance performed on the system.

b. What is the water source?

(1) Shore (direct pressure).

(2) Ship's tanks filled with shore water.

(3) Mixture of water remaining in ship's tanks and shore water.

(4) Barged water.

(5) Another ship.

(6) Produced by ship's distiller.

c. Does the water have a characteristic taste or odor? This is quite vague, but sometimes it is possible to determine the source of a water problem by a distinctive taste or odor.

d. Is the problem isolated in one section of the ship or does it occur throughout? If the problem affects only a particular section, concentrate the investigation on occurrences affecting the piping system or tank supplying that section. Cross-connections, repairs to, or maintenance on the piping system, sounding tubes, or a particular tank are possible sources of the problem.

e. Is the problem continuous or does it occur only while a particular tank is on-line? If the problem appears to be cyclic, compare the record of complaints and the particular tank(s) supplying water to different sections of the ship. Additionally, use halogen residual testing to observe whether the tank or particular sections of the piping system display increased halogen demand.

f. Can the system maintain halogen (chlorine or bromine) residuals? Routine surveillance using halogen residual testing should have identified this problem in the system. It is important now to test the on-line tank and several points in the system. If the proper residual is not present in a tank after adequate disinfecting and contact time, the problem may be inside the tank or indicate inadequate disinfection practices.

g. Has the ship experienced similar taste or odor problems in the past? Discussion with Engineering personnel may provide information about a history of similar problems.

h. Review the potable water log to identify fluctuations that might occur in the potable water distribution system. To do so, plot a simple graph with halogen residual levels on the vertical axis and days on the horizontal. In plotting this data for the past three months, the MDR can develop an accurate picture. Compare this data with the water source and tanks on-line at the time. A pattern associated with a particular water source or individual tank may emerge.

i. Identify potable water tanks with common bulkheads to fuel, ballast, or other tanks or bilges. The source could be a small leak that creates persistent taste or odor problems in a potable water tank with such a common bulkhead. Do not overlook identifying these tanks or associated non-potable liquids that may contaminate the potable water system as the source of the problem.

j. Identify any non-potable piping permanently installed through potable water tanks. Any piping through potable water tanks should be enclosed in self-draining pipe tunnels to avoid contaminating the water system. In many instances, an EDR can evaluate this piping only by entering the tanks, but engineering records should show the location and existence of this type of piping.

k. Evaluate water disinfection procedures to ensure Engineering personnel used proper amounts of disinfectants. While the Engineering Department treats water, including disinfecting, MDRs must understand the system and review disinfection procedures to ensure Engineering personnel are adding proper amounts of halogens to achieve the necessary chlorine or bromine residuals in the distribution system.

l. Identify any repairs to or maintenance operations on the potable water distribution system that could have contributed to the taste or odor problem. Numerous points in the potable water system can contaminate through either cross-connections or as a result of repairs or maintenance. The MDR should review these operations and correlate their location in the system as possible contaminants.

m. Has the MDR monitored the water remaining in potable water tanks while the ship is at the pier on direct service? It is possible to ignore water remaining in potable water tanks when the ship is tied up to the pier. Consequently, the water may sit for a long time, become stagnant, and cause taste or odor problems immediately on resuming tank use.

n. Did the MDR evaluate potable water tanks by halogen testing or bacteriological analysis before the Engineering Department filled them with shore water? If shore water mixes with water that sat in the tanks for extended periods, taste or odor problems may occur. It is advisable to check the water in the tanks for adequate halogen residual and bacteriological analysis before filling with shore water.

o. Identify each potable water tank's coating type and application date and location. An improperly applied or cured potable water tank coating may cause a temporary or permanent taste or odor problem. Usually shipboard personnel cannot easily evaluate a tank coating. A temporary taste problem after applying new tank coatings is not unusual, but should resolve after using the tank. In contrast, lack of ability to maintain halogen residuals in the tanks accompanied by persistent taste and odor problems may directly relate to an improperly applied or uncured tank coating.

5. Controlling Taste or Odor Problems.

a. As previously noted, mechanical processes to control taste or odor are quite limited aboard ship. Identifying and eliminating the source of foul taste or odor is of the utmost importance to members. In a ship at sea whose system must be used, increasing the residual chlorine levels can aid in controlling taste or odor problems.

b. Municipal water systems ashore use increased residuals as a control measure for bad taste and odor. The elevated chlorine residuals often satisfy the halogen demand existing in the tanks or pipes. Therefore, ships unable to identify a source of taste or odor should add sufficient chlorine to produce a dosage of 5 ppm in the potable water tanks, with the intent of providing 2.0 ppm free residual chlorine in the water distribution system. This procedure may satisfy the tanks' or system's halogen demand and resolve temporary taste and odor problems.

6. Request for Outside Assistance.

   a. An MDR who has evaluated the situation as outlined in ☛ Paragraph 1.G.2. and has been unable to determine the source of the taste or odor problem should contact the area MLC for technical assistance by either telephone or submitting a Potable Water Discrepancy Report as shown in ☛ Appendix 1.B. Medical and appropriate Engineering personnel should be prepared to discuss their evaluation of specific items listed in ☛ Paragraph 1.G.2.

   b. MLC (kse) personnel will thoroughly evaluate all aspects of the taste or odor problem aboard the ship. If they cannot assist the MDR in person due to geographic location, MLC(kse) will request the closest Navy Preventive Medicine Department or Unit to provide onboard assistance in reviewing the problem.

   c. MLC (kse) personnel will thoroughly review the situation and recommend appropriate steps to resolve it. If they either cannot resolve the problem or suspect tank coatings as the cause, they will summarize their investigative results and provide them and recommendations to COMDT (G-WKS) through the chain of command.

H. Cross-Connections.

1. Scope. Improperly cross-connected piping has contaminated potable water and caused numerous water-borne disease outbreaks. In recent years, the potential for cross-connections between potable and non-potable systems has significantly increased due to back-flushing sewage collection tanks and associated piping. The MDR must constantly monitor potential cross-connection problems from biological or chemical sources. In contrast to a shore facility, plumbing aboard ship is a maze of piping systems fitted into a relatively compact space. The numerous separate piping systems carrying fuel, sewage, salt water, potable water, etc., offer distinct possibilities for cross-connections, particularly during repair, modification, or negligent operations.

2. Definitions.

   a. Cross-Connection. Any connection between two separate piping systems, one containing potable water and the other water of unknown or questionable quality or some other substance. This condition may result in the flow of liquid from one system to the other, contaminating the potable water supply.

   b. Backflow. The unwanted reverse flow of liquids, solids, or gases into the potable water system. Backflow can refer either to back-siphonage or backflow caused by back-pressure.

   c. Back-Pressure. A pressure greater than the supply pressure that may cause backflow in the potable water system.

d. Back-Siphonage. Negative pressure in the potable water system drawing non-potable water or other substances "by suction" into the potable water system through cross-connections or outlets. The risk of back-siphonage increases when the potable water system is secured during water hours or for any other purpose.

e. Submerged Inlet. A potable water supply faucet or other outlet, including an attached hose, located below the fill level of a sink, tub, container, tank, machine, etc.

f. Air Gap. The actual vertical separation between a potable water supply outlet and the highest possible level of liquid in the sink, tub, container, tank, machine, etc., receiving the water. The separation actual distance must be at least twice the diameter of the potable water supply pipe between the outlet and the highest possible liquid level in the receiving object but always at least one inch (1").

g. Backflow Preventer Devices. Devices designed to prevent backflow and subsequent contamination of the potable water supply. These devices are installed at locations requiring direct connections to the potable water system, e.g., dishwashing machines and water closets. Several types of backflow prevention devices are available. Choose the proper application to protect the water supply from among these approved types:

(1) Atmospheric Vacuum Breaker. This backflow prevention device is necessary on a potable water outlet designed for an attachment that does not have a shutoff downstream from the vacuum breaker. It is not designed for continuous pressure.

(2) Hose Connection Vacuum Breaker. This device attaches directly to a hose bibb. It has a single check with an atmospheric vacuum breaker vent. It is not designed for continuous pressure.

(3) Specialty Backflow Preventer with Intermediate Atmospheric Vents. A device with two independent check valves—an intermediate vacuum breaker and a relief valve. Used in low-hazard situations, it is effective under constant pressure.

(4) Reduced Pressure Zone (RPZ) Backflow Preventer. This device has two independent check valves with an intermediate relief valve for use in high hazard situations and continuous pressure applications. It is supplied with shut-off valves and ball-type test cocks. It must be tested annually; attach the annual test record to the RPZ or file it with the maintenance records.

3. Selecting and Installing Backflow Prevention Devices.

a. When potable water is supplied under pressure, vacuum breakers, backflow preventers, or air gaps between the water delivery point and the equipment overflow rim must protect the system against backflow or other contamination. In general, any type of potable water supply connection to equipment allowing the flow of toxic liquid or contaminated water into the potable water system is not permissible. The

Engineering Department must install vacuum breakers or backflow preventers if air gaps are impractical or water under pressure is required.

b. Atmospheric Vacuum Breakers. Install these devices under these conditions:

(1) No valves can be installed downstream.

(2) Critical level must be 6 inches above the highest point downstream where back-pressure could be created.

(3) Critical level must be 6 inches above the receptor's flood level rim.

(4) Only suitable for back-siphonage situations; not appropriate for back-pressure conditions.

(5) Nominal diameter is at least equal to the line size.

c. Hose Connection Vacuum Breakers. Install these devices under these conditions:

(1) No continuous pressure can be applied to the device.

(2) Must be installed on the control valve's discharge side.

(3) Maximum working pressure is 125 psig.

(4) Temperature range is 33° to 180° F.

(5) Will prevent back-siphonage or maximum back-pressure of 4 psig (10 feet of head pressure.

(6) Can be used in low- to high-degree hazard situations.

d. RPZ Backflow Preventers. Install these assemblies under these conditions:

(1) Control valves are required upstream and downstream.

(2) An air gap must be provided for discharge from vent port.

(3) The assembly must be tested before initial use and annually thereafter.

(4) Maximum back-pressure cannot exceed twice the device's rated working pressure.

(5) Suitable for continuous pressure.

(6) Can be used in low- to high-degree hazard situations.

(7) The Engineering Department must provide drainage.

e. Double-Check Valve Assemblies. Install these assemblies under these conditions:

(1) Can be used as backflow preventer only in fire protection systems.

(2) Cold devices' temperature range: 33° to 110° F; hot devices' temperature range: 40° to 180° F.

(3) 150 psi working pressure.

(4) Use only in low-hazard situations.

f. Other Backflow Prevention Devices. Consult with area MLC (kse) staff for guidance in properly selecting and installing other types of backflow preventers.

4. Defective Piping Installation. Observers have identified these examples of defective piping installations that have caused disease outbreaks aboard ship:

a. Backflow.

(1) Salt and potable water lines connected to a common line or outlet.

(2) Direct potable water connections without backflow prevention devices to machines, equipment, and non-potable systems.

(3) Boiler feedwater and potable water lines connected to a common line.

(4) Drains from ice machines or food service equipment, e.g., dishwashers or food preparation sinks, plumbed directly to the deck drainage or sewage system with no air gap.

b. Back-Siphonage.

(1) Laundry trays, wash basins, service sinks, and deep sinks with faucets below the fill level.

(2) Drinking fountains with orifice below the fill level, or the vertical jet or orifice supply line surrounded by the waste drain line.

(3) Therapeutic tubs or steam tables with inlets below the fill level.

(4) Improperly installed water-operated waste ejectors, e.g., potato peelers and garbage grinders.

(5) Potable water hose connections installed without vacuum breakers, or with attached rubber hoses allowed to remain in sinks or photo tanks.

5. Potential Contamination Sites. Both ship and shore MDRs should review these locations, conditions, equipment, and concerns to determine their potential to contaminate the potable water system through cross-connections to non-potable water, backflow, or back-siphonage:

a. Potable water supply lines to swimming pools, whirlpools, hot tubs, bathtubs, and similar facilities.

b. Photography laboratory developing machines and utility sinks.

c. Beauty or barber shop spray and rinse hoses.

d. Potable water faucets where hoses are or are likely to be connected, e.g., deep sinks, food preparation sinks, and weatherdeck hose bibbs, including hoses to tanks containing chlorine and other chemicals.

e. Garbage grinders.

f. Dish- and glass-washing equipment.

g. Sick bay and laundry equipment.

h. Air conditioning supply tanks.

i. Boiler feedwater tanks.

j. Fire systems.

k. Potable water, bilge, and sanitary pump priming.

l. Fresh- or saltwater ballast systems.

m. Bilge or other waste water.

n. Air gaps between all potable and non-potable systems.

o. Lines to divert potable water to other systems by valves or interchangeable pipe fittings, acceptable only when an air gap follows a valve.

p. A common compressed air system supplying pressure to both non-potable and potable water pneumatic tanks; the air supply must be through a press-on type of air valve or hose manually held in place. A fixed connection for this valve is allowed only if the air supply is from a separate compressor used exclusively for potable water pneumatic tanks.

q. Vacuum breakers located on the discharge side of the last control valve (flushing device) and at least 6 inches above the fixture's flood-level rim must protect any potable water supply connected to a toilet system.

r. Feedwater to hot wells.

s. Feedwater to oily water separators.

t. X-ray developer connections.

6. Monitoring and Inspecting Potable Water Supplies.

    a. Garbage grinders, x-ray developing machines, photographic chemical mixing tanks, and photographic film and print processing machines normally are hard-plumbed or have a permanent flexible hose installed to receive potable water through a reduced-pressure backflow preventer installed above the overflow level.

    b. Throughout the ship, install an atmospheric or hose-bibb vacuum breaker anywhere a hose bibb faucet permits a hose connection to the potable water system; e.g., at deep sinks and galley and weather deck washdown faucets.

    c. MDRs should routinely check for cross-connections during water surveillance, water sample collections, sanitation inspections, and halogen residual tests. Modifying or repairing existing potable water systems aboard ship should alert the MDR to potential cross-connection problems. Frequent discussion with Engineering personnel about the potable water system and any proposed repairs or changes may be extremely beneficial in preventing cross-connections. If an MDR suspects or identifies a cross-connection he or she must quickly, effectively determine whether the condition is unsatisfactory. The MDR should thoroughly discuss the problem with the Engineering Officer and review the suspected site and ship diagrams. An MDR identifying a cross-connection has the primary responsibility to prevent a disease outbreak from occurring so he or she should recommend the EO secure the affected part of the potable water system until the Engineering Department can eliminate the cross-connection and disinfect the potable water system, if necessary.

I. Manufacturing and Handling Ice.

1. Manufacture. Most ships use ice cube machines or ice makers to make ice, though a few small pantries, galleys, general messes, and very small ships still use ice cube trays. To reduce bacterial growth, use potable water to prepare all ice used for food or drink or to maintain food at acceptable temperatures. Regardless of the end use, prepare all ice in a sanitary manner and protect it identically to water. See the ☛ Food Service Sanitation Manual, COMDTINST M6240.4 (series), for additional sanitary requirements.

2. Special Precautions. Because ice is vulnerable to contamination, special handling and storage precautions are necessary.

    a. Prepare all ice from potable water.

    b. Ice machines must be plumbed properly to eliminate possible cross-connections and back-siphonage.

    c. The ice machine drain from the ice storage compartment must have an air gap between the ice storage compartment and the deck drain.

d. Use an ice scoop to remove ice from the storage hopper. Store the ice scoop outside the ice storage compartment.

3. Cleaning and Disinfecting. The ☛ Food Service Practical Handbook, COMDTINST P4061.4 (series), contains disinfection procedures for ice cube machine hoppers and flaking devices.

4. Bacteriological Quality.

a. The MDR must collect ice samples monthly for bacteriological examination; ice must conform to the standards for potable water.

(1) If ice samples collected for bacteriological analysis test positive for coliform organisms, food service personnel should empty, clean, and disinfect the storage bin.

(2) Improper handling techniques or dirty storage bins usually cause contaminated ice.

b. The MDR must enter results of bacteriological examinations of ice samples in the Potable Water Quality Log, CG-5648, shown in Appendix 1.A.

J. Water Testing Requirements and Procedures.

1. Scope.

a. All testing requirements and procedures must comply with *Standard Methods for the Examination of Water and Wastewater*, most current edition, published jointly by the American Public Health Association (APHA), American Water Works Association (AWWA), and Water Pollution Control Federation (WPCF). The tests described here are minimal for water from approved sources; supplement them with additional tests if the water source is of doubtful quality.

b. Analyzing water for suspected chemical contaminants is very complex. The equipment necessary to perform these determinations is not available aboard ship. If an MDR suspects chemical contamination, with or without illness, he or she must request outside assistance from the area MLC (kse) immediately.

2. Temperature and pH.

a. These tests are important to the Engineering Department because water temperature and pH deviations may affect treatment or disinfection procedures. Halogenation is more effective at lower, more acidic pH values and warmer temperatures. Alkaline pH levels (8.5 or higher) adversely affect chlorine's or bromine's disinfecting properties. When chlorine enters water, it forms hypochlorous acid (HOCl) and hypochlorite ions (OCl-) in proportions depending on the pH: the lower the pH, the more hypochlorous acid. Since hypochlorous acid is chemically neutral, it diffuses more readily through microorganisms' membranes than does the charged hypochlorite ion. Thus chlorine is more effective as a bactericide at a low pH. Water temperature affects the amount of bromine the cartridge releases; high temperatures may deplete the cartridge more rapidly.

b. Test for pH when testing for halogen residual; enter the results in the Potable Water Quality Log, CG-5648, shown in ☛ Appendix 1.A.

c. The MDR also can test for pH using the DPD chlorine-bromine-pH combination test kit, it is a standard stock item (NSN 6630-01-067-3827).

3. Salinity. When operating in sea water, the chloride content of water from a distilling plant shall be 0.065 equivalent per million (epm) or less, 0.25 grains of sea-salt per gallon, or less than 2.3 ppm. See the individual distilling plant's technical manual for testing procedures.

4. Halogen Residual (Chlorine or Bromine) Testing.

a. This is an extremely important test since potable water's bacteriological safety depends on residual concentrations of free available chlorine (FAC) or total bromine residual (TBR). FAC and TBR represent the amount of halogen present in potable water after adequate disinfection. FAC refers to hypochlorous acid, a far more effective disinfecting agent than combined chlorine (chloramines). In a colorimetric test, the combined chlorine is distinguished from FAC by the length of time before the color appears after adding the color indicator chemical to the water sample. FAC and TBR react rapidly; therefore, an immediate reading of the result is necessary (60 or fewer seconds).

b. Regardless of water source, ships must maintain as a minimum, a trace FAC or TBR throughout the potable water distribution system after initial treatment. MDRs shall test for halogen residuals under these conditions:

(1) Before receiving potable water on board.

(2) In conjunction with each potable water sample collected for bacteriological analysis.

(3) Daily, from various sampling points that represent the ship's distribution system, e.g., forward, amidships, aft, below deck, and in the superstructure.

(4) As part of evaluating the treatment process, the Engineering Department tests chlorine or bromine residuals in potable water tanks after 30 minutes' contact time.

c. DPD Test. The DPD (diethyl-p-phenylene diamine) test determines chlorine or bromine residuals. The test kit comparator gives direct readings for both chlorine and bromine, read over two ranges.

	Chlorine	Bromine
Low Range	0.1 to 1.0 ppm	0.2 to 2.2 ppm
High Range	2.0 to 10.0 ppm	4.4 to 22.2 ppm

To read the low range put the sample test tube in a slot directly behind one of the colorless windows located on the back of the comparator and read the low range comparison. To read the high range put the sample tube in one of the openings located on top of the comparator and make the reading. Move the test sample tube from one position to another until a color match is made. Different DPD test kits are available, e.g., LaMotte model LP-NS (NSN: 6630-01-067-3827); follow the specific test's instructions. Use this general procedure to obtain both FAC and TBR:

(1) Open potable water tap and let flow at least 2 minutes.

(2) Rinse the test tube with the water to be tested.

(3) Fill test tube with sample water to the marked line (10 ml).

(4) Add one DPD No. 1 tablet, cap the test tube, and shake to dissolve.

(5) REMOVE THE CAP FROM THE TEST TUBE because this affects the color. Immediately compare the test sample color with the color standards in the comparator. Complete the color matching within one minute after adding the DPD No. 1 tablet.

(6) Record the value of the matching color standard. If the color falls between consecutive color standards, take an intermediate value. If the color is deeper than the 5.0 ppm chlorine or 11.0 ppm bromine color standard, add one (1) additional DPD No. 1 tablet to obtain a full color response. No formulation is required for the extra tablet; take a direct reading and record.

(7) When testing a water supply disinfected with chloramines, determine the total residual chlorine by using DPD tablet No. 4. The reading from this tablet will not differentiate among types of chlorine, but will indicate the total levels of disinfectant present. If it is necessary to determine the type of chlorine present other than FAC (total chlorine residual), obtain specific guidance from the area MLC (kse). This is the test procedure for total chlorine residual:

   (a) Rinse the test tube with the test sample, then fill to the mark.

   (b) Add one DPD No. 4 tablet and allow the tablet to disintegrate rapidly (it will effervesce); then cap the test tube and shake to mix.

   (c) The resulting color represents the total residual chlorine.

(8) When testing for halogens in the water supply, determine whether bromine or chlorine is being used and record as either bromine or chlorine after testing.

(9) When testing for extremely high levels of chlorine, i.e., superchlorination, it is necessary to dilute the water sample to determine the chlorine residual. A 1:10 dilution using distilled water as the diluent is satisfactory for this purpose; to determine the chlorine residual, multiply the test reading by 10.

(10) Record halogen residual test results in the Potable Water Quality Log, CG-5648, shown in ☛Appendix 1.A.. Report absence of halogen residuals in the potable water system to the CO with a copy to the Engineering Officer. Prepare and submit a Potable Water Quality Discrepancy Report if halogenation problems are not immediately corrected. See ☛ Paragraph 1.J.6. for details.

5. Bacteriological Collecting and Testing.

a. The shipboard test measure to determine the suitability of water for human consumption is bacteriological purity, which ascertains whether disinfection has fully destroyed pathogenic organisms in the water.

b. Units without assigned health service duty technicians are exempt from conducting bacteriological testing if the ship's water system provides a documented, reliable disinfectant trace residual throughout the distribution system at an effective pH level (6.8-7.8). If water meets these criteria, bacteriological contamination is rare or non-existent.

c. Units with assigned independent duty health services technicians will perform weekly bacteriological tests on samples collected at representative points throughout the distribution system including potable water tanks, ice machines, and potable water retained in storage tanks when under direct service from shorelines. Take tank samples from petcocks on the tank; if not available, collect the sample from the outlet nearest the tank. On ships so equipped, use the brominator recirculation test taps to obtain samples from each tank. Record all results in Part II of the Potable Water Quality Log shown in ☛ Appendix 1.A.

d. Base the number of samples on the size of the ship's storage and distribution system, crew size, potential for disease outbreak from water sources, mission duration and complexity, the ability to conduct underway replenishment (UNREP), and other high-risk activities. Cutters with assigned independent duty health services technicians must perform bacteriological testing and daily halogen residual testing. Vessels required to conduct bacteriological testing will collect at least four (4) samples per month in accordance with ☛ Chapter 3.B. Collect and test special samples more frequently when chlorine demand increases or contamination is suspected, after cleaning and disinfecting tanks, and on completing system repairs. When collecting samples, follow the procedures in ☛ Chapter 3.

e. Coliform microorganisms indicate fecal contamination. EPA-approved tests for total coliforms include the minimal media ONPG MUG (MMO-MUG) Colilert test and the Membrane Filter (MF) technique; see ☛ Chapter 3.

(1) The Coast Guard has adopted Colilert Test (MMO-MUG), described in ☛ Chapter 3, as the method of choice to determine whether coliforms are present in shipboard potable water distribution systems.

(2) The Maximum Contaminant Level (MCL) for coliform bacteria (also called total coliforms) is based on the presence or absence of coliforms in a sample rather than on an estimate of coliform density. The MCL for ships analyzing fewer than 40 samples per month is no more than one sample per month may be total coliform-positive. However, all total coliform-positive samples require prompt retesting and reporting as indicated in this section. The presence of *any* coliform organism is a danger sign.

(3) Each shipboard potable water system must be sampled as required by ☛ Paragraph 1.J.5.c. above.

(4) For each total coliform-positive sample repeat the test and analyze for total coliforms. Take at least one repeat sample from the same tap as the original sample. Collect two additional repeat samples, one each up- and downstream, from within five service connections of the original positive sample. If the original positive sample is at the end of the distribution system, collect both samples downstream. If total coliforms are absent in these samples, the water is safe to use.

(5) Analyze any routine or repeat total coliform-positive sample culture for fecal coliforms or *E. coli* using EPA-approved methods. ☛ *Standard Methods for the Examination of Water and Wastewater* contains test methods for fecal coliforms. Analyze *E. coli* using methods described in the ☛ 8 Jan 91 *Federal Register* (56 FR 642) and/or ☛ *Standard Methods*. If, however, the MDR considers all coliform-positive samples also fecal coliform- or *E. coli*-positive, he or she need not further test shipboard systems. If so, the MDR also considers each total coliform-positive sample fecal coliform- or *E. coli*-positive and counts it in the monthly Potable Water Quality Log. Smaller ships not capable of performing confirming fecal coliform or *E. coli* analyses must consider all total coliform-positive cultures as fecal coliform- or *E. coli*-positive. Ships that can perform confirmation tests for fecal coliforms or *E. coli* have two options: either perform fecal coliform or *E. coli* confirmation tests of all coliform-positive cultures or consider each total coliform-positive culture as fecal coliform- or *E. coli*-positive.

(6) Prepare and submit a Potable Water Quality Discrepancy Report shown in ☛ Appendix 1.B. through the appropriate command channels to the supporting area MLC (kse) if coliform bacteria test results are positive. Continue to submit these reports until two consecutive coliform bacterial tests are negative. See ☛ paragraph 1.J.7. for details.

6. Potable Water Quality Log.

a. Maintain a two-year chronological record of potable water monitoring. On larger ships with a Health Services (HS) Technician, the HS will maintain all potable water records; on other ships the Medical Department Representative will do so.

b. Prepare and submit the Potable Water Quality Log (PWQL), CG-5648, to the unit Commanding Officer monthly; ☛ Appendix 1.A. shows a sample authorized for local reproduction. Make chronological entries; they must include at least this information:

(1) Time and date each water sample was taken.

(2) Ship's location: at sea, in harbor, at anchorage, or in port; if in port, its name.

(3) Source of ship's water: the ship's distilling apparatus, water barge, shore using direct pressure, or ship's tanks filled with ashore water. Also note the water source (approved or non-approved), its halogen residual, and whether disinfected.

(4) Sampling site: location of outlet, ice machine, emergency potable water tank or supply, and potable water tank's identification number, etc.

(5) Tests Performed.

(a) Halogen Residual. Specify if bromine or chlorine, amount or absence of residual, reason taken, e.g., daily, bacteriological analysis, before receiving water, or after disinfecting tanks or lines. Include any follow-up action taken for negative readings.

(b) pH. Record the results of pH tests.

(c) Bacteriological Analysis. Record all test results, including positive and negative controls. If performed, record the results as total coliform-present or total coliform-absent if fecal coliform or *E. coli* has not been confirmed. State the reason to perform the test, e.g., weekly, special, or after disinfecting tanks, lines, or systems. Record action taken and results for positive samples even if another activity performed the tests.

(d) Initials. The person performing the tests should record his or her initials.

(e) Problems. Record any taste or odor problems and their resolution on the reverse side of the Log.

(f) Inspection and Surveys. Include results, discrepancies, and action taken on the reverse side of the Log.

7. Potable Water Quality Discrepancy Report. All commands will submit a Potable Water Quality Discrepancy Report (PWQDR) through command channels to the servicing area MLC(kse) if product water fails to meet the quality requirements listed in this Chapter or product water quality is suspect, except *only* if a halogenation deficiency is corrected immediately. Use a message format for this report; ☛ Appendix 1.B. contains a sample. Continue to submit PWQDRs until satisfactory water test results verify the problem has been resolved.

K. Water Sanitation Bill.

Each ship should have a Water Sanitation Bill developed to meet its individual, unique conditions. The Commanding Officer should promulgate the Water Sanitation Bill and post it conspicuously in areas where potable water and associated materials are processed, treated, or stored. ☛ Appendix 1.C. presents a sample bill offered as a guide only.

Appendix 1.A. Potable Water Quality Log

Month: ______________________ Unit: ______________________

Submitted by (Print or Sign Legibly): ______________________ Date: ______________________

Date	Time	Ship's Location	Water Source	Sampling Site	FAC/TBR (ppm)	pH	Initials
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							

Part II: Bacteriological Test Results MF = Membrane Filter Method (result: number of colonies per 100 ml)
CL = Colilert Method (result: presence or absence)

Collected		Sample Location	Type		Analysis		Method MF or CL	Results Total/Fecal	Analyst's Name
Date	Time		Reg	Cntrl	Date	Time			

NOTE: Submit a Potable Water Discrepancy Report to MLC (kse) if results do not meet standards found in the Water Supply and Wastewater Disposal Manual, Chapter 1.J.

DEPT OF TRANS., USCG, CG-5648 (11/99)

Appendix 1.B. Sample Potable Water Quality Discrepancy Report

FM (UNIT NAME)
TO COMCOGARD MLC LANT(PAC)//K//
BT
UNCLAS//NO5100//
SUBJ: POTABLE WATER QUALITY DISCREPANCY REPORT
REF A COMDTINST M6240.5 (series), WATER SUPPLY AND WASTEWATER DISPOSAL MANUAL

1. AS REQUIRED BY REF A, RESULTS OF BACTERIALOGIC TESTING OF SHIP'S EVAP SYSTEM CONDUCTED ON [insert date] WERE POSITIVE FOR TOTAL COLIFORM BACTERIA BUT NEGATIVE FOR E-COLI. CAUSE OF SUPECTED CONTAMINATION IS UNKNOWN. SHIP'S TOTAL BROMINE RESIDUAL WAS ZERO WHEN SAMPLES WERE TAKEN. SHIP IN TRANSIT TO PANAMA AND MAY HAVE TAKEN ON CONTAMINATED WATER AT RECENT PORT CALL IN MEXICO.
2. SHIP TOOK THESE CORRECTIVE ACTIONS TO ELIMNATE POSSIBLE CONTAMINATION: SUPERCHLORINATED SYSTEM TO 100 PPM RESIDUAL CHLORINE, RINSED, AND INCREASED BROMINE RESIDUAL FROM 0.2 PPM TO 2.0 PPM.
3. WILL CONTINUE TO TEST FOR BACTERIAL, BROMINE RESIDUAL, AND PH LEVELS AND SUMBMIT PWQD REPORT UNTIL PROBLEM RESOLVED. POC IS THE SHIP'S EO AT [insert telephone number].

BT
NNNN

Appendix 1.C. Sample Potable Water Sanitation Bill

USCGC ALWAYSSAIL

1. Responsibility.

    a. The Engineering Department supplies potable water and treats it as required; the Department also operates and maintains the equipment that produces potable water.

    b. The Medical Department Representative (MDR) monitors all aspects of potable water treatment, handling, and storage to ensure they comply with current instructions to protect the potable water supply. Additionally, the Medical Department collects and examines representative samples to monitor potable water for quality.

2. Sources.

    a. Processing Sea Water. Do not distill or use reverse osmosis (RO) to process harbor water or polluted sea water except in emergencies. Assume sea water is polluted when ships are operating in close formation. While making potable water, take care not to strip fuel waste tanks or empty bilges or sewage forward of the salt water intakes.

    b. Potable Water. Potable water may be received from shore facilities or other ships from these approved sources:

        (1) U.S. military-owned and/or -operated facilities.

        (2) Water points listed in the joint U.S. Public Health Service and Food and Drug Administration publication ☛ *Acceptable Vessel Watering Points Interstate Conveyance Official Classification List.* The Area Maintenance and Logistics Command (kse) and Navy Environmental and Preventive Medicine Units (NAVENPVNTMEDUs) can provide this list; contact them as necessary. Obtain other source data from the U.S. military representatives ashore or the MLC (kse) having area responsibility.

3. Procedures for Ship-to-Shore and Ship-to-Ship Connections.

    a. When available trained shore-based personnel should make or supervise all shore connections; however in many instances ship personnel must assume this responsibility. Personnel trained in handling potable water also shall transfer potable water ship-to-ship.

    b. Cutters should furnish their own potable water hoses in ship-to-shore connections. In sea transfers, the supplying ship normally provides hoses.

    c. An MDR must ensure an adequate halogen residual is present in the water before the water is transferred.

d. Flush the potable water outlet for 15 to 30 seconds and disinfect with a solution of 100 ppm free available chlorine (FAC). Let stand for two minutes and flush again.

e. Flush the hose for 15 to 30 seconds; then connect to the ship.

f. Conspicuously designate potable water ship risers by a warning plate with the inscription POTABLE WATER ONLY in one-inch letters. The connection shall be at least 18 inches above the deck and covered with a screw cap attached by a keeper chain when not in use.

g. The member hooking up the intake hose must ensure it is connected ***ONLY*** to a shipboard potable system.

h. Never submerge the hose in harbor water.

i. Follow the precautions and procedures above when making ship-to-ship potable water hose connections.

4. Potable Water Hoses. Use only potable water hoses for potable water. Mark potable water hoses POTABLE WATER ONLY approximately every 10 feet. Transfer potable water only through hoses disinfected by filling for 2 minutes with 100 ppm FAC solution. After disinfecting, couple or cap hose ends and store in lockers at least 18 inches above the deck and protected from weather, dust, and vermin.

5. Storage Tanks. Except in extreme emergencies, do not fill potable water tanks with ballast water. If tanks have been used for ballast water, disinfect tanks, pipes, fittings, and pumps used before refilling with potable water.

6. Disinfecting. Use only these halogens to disinfect potable water:

Table 1.A.1.: Disinfectants

Type	NSN Stock Number	Unit Size
Calcium hypochlorite technical 65 to 70% (HTH)	6810 00 255 0471	6-ounce jar
Sodium hypochlorite (5%)	6810 00 598 7316	1-gallon bottle
Sodium hypochlorite (5%)	6810 00 900 6276	5-gallon pail
Bromine	4610 01 022 9970	Cartridge

a. Calcium Hypochlorite. In a container mix enough chemical in warm water to obtain the required residual and allow it to settle. When the tank is one-quarter full, pour the clear chlorine solution into it. Never introduce this solution into the tank by using brominating equipment. If adding chlorine solution to a full tank, circulate the water through a pump to ensure adequate mixing. If the required level of chlorine is not present after a 30-minute contact period, add more chlorine solution.

b. Sodium Hypochlorite. When the tank is one-quarter full, add enough chemical solution to obtain the required residual directly to the tank; no prior mixing or dilution is required.

c. Hypochlorinators. Refer to the manufacturer's literature for operational instructions and requirements.

d. Brominators. Brominating a potable water system requires two different brominators: one is used in the distillate discharge line from the Evaporator or RO system; the other treats water in the tank while recirculating potable water.

7. Residual Halogen Testing.

a. The MDR or designee must determine the halogen residual in the potable water daily by performing chlorine or bromine tests. The stock system includes a DPD chlorine-bromine-pH combination test kit, e.g., NSN 6630-01-067-3827. Perform tests at random locations to ensure adequate coverage of the entire system. Every week the MDR will test the potable water distribution system and ice machines with storage compartments.

b. Record halogen residual test results in the water log. Report continual absence of halogen levels to the Commanding Officer (CO) with a copy to the Engineering Department.

8. Bacteriological Testing.

a. Weekly the MDR will perform bacteriological tests on samples collected at representative points throughout the distribution system and from potable water tanks. Sampling locations include potable water in storage tanks while the ship is in port, while the system receives direct service from shore potable water lines, emergency potable water tanks in the battle dressing station, and one-fourth of the ice machines. Perform special or more frequent tests whenever chlorine demand increases, contamination is suspected, after cleaning and disinfecting tanks, and on completing repairs to the system.

b. If the results of a sample are total coliform-positive, take a set of repeat samples for each total coliform-positive sample and analyze for total coliforms. At least one repeat sample must be from the same tap as the original positive sample. Collect two additional repeat samples, one each upstream and downstream, from within five service connections of the original positive sample. If the original positive sample is at the end of the distribution system, collect two downstream samples. If total coliforms are absent in these samples, the water is safe to use.

c. Submit a report of the bacteriological test results to the CO and EO and enter the results in the Potable Water Quality Log.

9. Temperature, pH, and Salinity. Because temperature, pH, and salinity variations may affect the water treatment procedure, the Engineering Department must perform these tests at least daily.

10. Disinfecting Tanks and Distribution System. If mechanical cleaning and chemical disinfection are required, superchlorinate the potable water tank and, if necessary, the distribution system. Determine the volume of water in the tank and/or distribution system and add enough chlorine to raise the residual to 100 ppm FAC. Let stand four hours. During this interval, test hourly and then after four hours to make sure the water maintains the proper FAC of at least 50 ppm. If at any time during this period the FAC residual falls below 50 ppm, add sufficient chlorine to bring the residual to 100 ppm and restart the four-hour period.

11. Distribution System.

a. Use potable water lines *only* for potable water.

b. Do not cross-connect the potable water distribution system to any possible source of contamination.

c. Supply potable water to be used as boiler feedwater through an air gap.

d. Potable water lines must not pass through non-potable liquid storage tanks and non-potable liquid lines must not pass through potable water tanks unless a sloping, self-draining pipe tunnel surrounds the lines.

e. Label potable water lines as to the type of service and an arrow indicating the flow direction.

f. If any accidental or other break occurs in the potable water system, disinfect the affected parts after reassembly and before placing that part of the system back in service. The Engineering Department must notify the MDR about any break in the water distribution system.

g. Prime potable water pumps only with potable water.

h. Potable water must be used to manufacture all ice.

12. Required Records.

a. The Engineering Department shall maintain adequate records to furnish documentary evidence of having fulfilled its potable water production, treatment, and distribution responsibilities.

b. The MDR will maintain a two-year, chronological Potable Water Quality Log, e.g., CG-5648, with this information about potable water surveillance:

(1) For all water samples taken, the time and date, ship's location, ship's water source, and sampling site's location.

(2) For halogen residual tests, type of halogen; reason taken, e.g., daily, bacteriological analysis, before receiving water, disinfecting tanks or lines; results; and any follow-up action taken for negative readings.

(3) For all bacteriological analyses, including controls, reason performed, e.g., weekly, special, or disinfecting tanks or lines; results; and action taken on positive samples, even if another activity performed the tests.

(4) Any repairs or modifications to the potable water system or tanks; any taste or odor problems and their resolution; and inspection and survey findings and any action taken.

c. The MDR shall submit a Potable Water Quality Discrepancy Report through command channels to the servicing area MLC (kse) if product water fails to meet the Water Supply and Wastewater Disposal Manual's quality requirements or is suspect, except only for halogenation problems corrected immediately.

d. The Medical Department Representative must frequently inspect the potable water procedures and system to ensure this Bill's provisions are followed. The MDR must report any discrepancies in writing to the CO with a copy to the EO.

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CHAPTER 2: COAST GUARD WATER SUPPLY ASHORE

A. Introduction and Policy

1. Purpose. This document provides public health information and guidance to military and civilian Coast Guard personnel who produce, store, environmentally monitor, and use potable water at fixed shore facilities.

2. Safe Drinking Water Act (SDWA). The Safe Drinking Water Act (SDWA) (PL 93-523), signed into law 16 December 1974, and later amendments direct the U.S. Environmental Protection Agency (EPA) to develop National Primary Drinking Water Regulations (NPDWR) for all public water systems' health standards. Under the law, individual states adopt primary enforcement authority (Primacy). Under the SDWA, EPA developed National Secondary Drinking Water Regulations (NSDWR) for all public systems' aesthetic qualities. Unlike the NPDWR, the NSDWR are not Federally enforceable, they are guidelines states may incorporate into state law and enforce. The NPDWR are found at ☛ Title 40, Code of Federal Regulations, Part 141(40 CFR 141); NSDWR appear in ☛ 40 CFR 143. ☛ Enclosure (1) contains relevant tables extracted from the SDWA. 1996 Amendments to the SDWA contain many new provisions, including a new consumer notification process and Federal facilities' loss of sovereign immunity, which means Federal agencies and installations, including the Coast Guard, can be subject to civil and administrative fines and penalties, leading to possible criminal prosecution for SDWA.

3. Policy on Primacy and the Safe Drinking Water Act.

   a. In states where EPA has granted primacy, U.S. Coast Guard facilities classified as water suppliers, i.e., these facilities own or operate a public water system, must follow NPDWR substantive and procedural requirements published by state regulatory authorities to conform with the SDWA.

   b. In states and territories not having primacy, U.S. Coast Guard facilities classified as water suppliers must follow NPDWR substantive and procedural requirements to conform to the SDWA as administered by the applicable EPA regional office.

   c. U.S. Coast Guard facilities classified as water suppliers located outside the continental United States (CONUS) must comply with NPDWR substantive and procedural requirements to conform to either the SDWA or host country's regulations, whichever more stringent. If complying conflicts with international agreements, status of forces agreements, or host country laws, or for whatever reason a facility cannot comply, it must submit a written request to deviate from CONUS drinking water standards through the area Maintenance and Logistics Command to Chief, Health and Safety Division, United States Coast Guard Headquarters, Washington, DC.

   d. G-WK establishes drinking water system standards and monitoring requirements aboard Coast Guard vessels, published in ☛ Chapter 1. When necessary, G-WK may publish additional water quality standards and monitoring requirements for Coast Guard ashore and afloat drinking water systems.

4. Responsibilities.

a. Coast Guard Headquarters (G-WKS):

(1) Updates the standard operating procedure for potable water monitoring as needed.

(2) Informs commands of related legislative and regulatory changes.

b. Maintenance and Logistics Commands:

(1) Provides to commands and activities technical and regulatory advice about how to comply with SDWA, 40 CFR 141, and states with primacy.

(2) Conducts sanitary surveys of command water systems and reports technical and administrative deficiencies.

(3) Determines command needs and assists commands in training and certifying water treatment plant personnel.

(4) Assists commands in developing contracts and selecting laboratory services to analyze potable water.

(5) At the Commanding Officer's request, negotiates with state regulatory officials, activities, state agencies, and EPA to ensure equitable, realistic compliance terms.

(6) Serves as liaison among commands, state agencies, and EPA.

(7) Verifies commands' overall regulatory compliance within respective geographic regions.

(8) As required by EPA and states having primacy, promptly reviews and notifies the public in incidents of command non-compliance.

(9) Assist units in preparing emergency and contingency plans.

c. Commanding Officers (COs) with public water systems:

(1) Operate and maintain facilities to manufacture drinking water that meets applicable standards.

(2) Per 40 CFR 141, notify the state or EPA and all persons the community water system serves of any failure to follow applicable substantive and procedural regulations.

(3) Ensure water treatment plant personnel are trained and certified according to EPA or state regulations.

(4) Ensure their units write a detailed emergency and contingency plan and update it every three (3) years or more often if needed.

(5) If public water system is classified as a community water system, ☛see Enclosure 4 for definition, prepare and distribute consumer confidence reports annually. ☛Refer to Federal Register, 19 August 1998 (Volume 63, Number 160), for details.

d. Integrated Support Command (ks):

(1) Ensure the MDR collects and analyzes samples.

(2) Send and maintain reports stipulated by 40 CFR 141 to EPA or states requiring them.

(3) Maintain copies of all potable water and/or wastewater records or reports sent to EPA or states.

e. Unit Engineering Officers (EOs):

(1) Coordinate with the cognizant medical authority to develop adequate water supply treatment techniques to ensure the water supply is free of disease-producing organisms, hazardous concentrations of toxic materials, and objectionable color, odor, and taste. At a minimum, ensure the water supply meets all applicable NPDWR and state water quality standards.

(2) Coordinate with the installation's medical authority to pursue an aggressive program to identify, isolate, and correct potential contaminants in the distribution system.

(3) Coordinate with Federal, state, and local agencies to set up a meaningful information exchange on local water resources, NPDWR, and NSDWR; maintain quality control data to ensure NPDWR or state requirements are observed.

(4) Ensure local water treatment personnel are trained to meet applicable operator certification requirements in their location; encourage personnel to attend short courses, seminars, and other formal instruction to keep current with technological improvements.

(5) Collect and ship water samples observing NPDWR and NSDWR.

(6) Notify the installation medical authority if a water main breaks or a similar incident occurs.

(7) Develop a program to correct system deficiencies. Upgrade equipment as needed. Flush and disinfect all newly installed mains and extensions before placing them into service.

(8) If responsible for a public water system, write an emergency and contingency plan that outlines departmental responsibilities and actions to minimize adverse impacts on the system if an emergency occurs. The plan also must outline remedial actions to take after such an event and before resumption of normal utility operations and service. Ensure the plan is reviewed and updated as often as needed but at least every three (3) years.

f. Medical Department Representative (MDR). The MDR or Safety and Environmental Health (SEH) personnel are advisors who recommend corrective measures when any water sanitation phase is unsatisfactory. Normally cooperation and communication with Engineering personnel will maintain adequate water quality. To fulfill this advisory role requires a water monitoring program tailored to each individual water system and including the activities listed below as a minimum. ☛Appendix 2.B. presents a model potable water monitoring program.

(1) Ensure compliance by maintaining liaison with Federal, state, and local regulatory authorities on current drinking water regulations.

(2) Periodically survey the potable water system to locate and identify possible health hazards.

(3) Test for halogen residuals, bacteriological quality, and other contaminants as needed to supplement sanitary surveys.

(4) Maintain or have access to a copy of the potable water, fire-fighting (if separate), and sanitary waste systems' plumbing diagram(s).

(5) Maintain records showing the facility's potable water supply system chemical, radiological, and microbiological quality.

(6) Monitor and recommend, when needed, disinfecting all new additions or repairs to water supply system mains, wells, pumps, storage tanks, and other units.

(7) Ensure all chemical additives to potable water supplies are water supplier- and state-approved, meet ☛ National Sanitation Foundation (NSF) International Standards, and are used in proper concentrations.

(8) Report all known or suspected cases of waterborne disease using the Disease Alert Reporting format found in the ☛ Medical Manual, COMDTINST M6000.1 (series).

5. Microbiological Considerations. One of the greatest deficiencies of customary methods to evaluate water's bacteriological quality is the MDR learns test results only *after* the sampled water has entered the distribution system. Successfully regulating the microbiological quality of drinking water depends on using relatively unchanging, high-quality raw water supplies. Testing is unlikely to detect localized contamination from leaking or broken water lines, back-siphonage, and cross connections early enough to prevent exposure. Also, such contamination almost certainly will overcome the low residual disinfectant maintained in the distribution system. It is essential to continue to use current microbiological monitoring techniques, imperfect though they are: they indicate the efficacy of disinfection and detect sanitary defects in the water distribution system. Overseas, water continues to be a major factor in the spread of disease. The MDR must pay special attention to water handling and treatment in these areas to reduce the spread of such disease. Regardless of where located, the MDR must immediately use the Disease Alert Reporting format found in the ☛ Medical Manual, COMDTINST M6000.1 (series) to report any known or suspected waterborne disease outbreaks.

6. Physiochemical Considerations. While the effects of microbiological contamination of potable water may manifest themselves within days, the effects of physical or chemical contaminants may take longer to manifest themselves. Physiochemical contaminants may be present in the water supply due to several factors. Naturally occurring inorganic and organic contaminants are plentiful in the environment; water readily assimilates and sometimes even acts as a solvent for many of them. Waste disposal and industrial uses also introduce trace metals, other inorganics, and organics into water. Both regulatory authorities and the public are becoming increasingly concerned about the presence of naturally occurring and man-made organics in drinking water.

7. Radiological Considerations. Researchers continue to examine the effects of naturally occurring and man-made radiological contamination in drinking water. $Radium^{226}$, present occasionally to man's activities but most usually as the result of geologic conditions, is the most important of the naturally occurring radionuclides likely to occur in public water systems. In contrast to radium, man-made radioactivity, mainly $Strontium^{90}$ and Tritium, is widespread in surface water from fallout from underground and atmospheric nuclear weapons testing. In some localities small releases from nuclear facilities, e.g., nuclear power plants, hospitals, and scientific and industrial operations, add to existing natural sources.

8. Potable Water Sources. ☛ Appendix 2.A. describes potable water sources in detail.

B. Water Distribution Systems.

Distributing water through substandard facilities will adversely affect water quality even if the water leaving a treatment facility is of satisfactory chemical and microbiological quality. System defects must not impair water safety and palatability. The distribution system must be structurally sound. Where possible its various mains and branches will not travel through surface or ground water. Minimize dead-end mains to ensure effective water circulation.

Lay water mains above sanitary sewers' elevation or, where parallel, at least 10 feet horizontally from such sanitary sewers. Where a sanitary sewer crosses over a water supply, the sanitary sewer must be in pressure pipe or encased in concrete for 10 feet on both sides.

1. Sanitary Standards: Cross-Connections. Interconnections between a potable water distribution system and a non-potable system are forbidden. Only by inspecting routinely can Engineering or SEH personnel control and eliminate hazards. Engineering or SEH personnel must periodically inspect every potable water distribution system to detect and remove all potential or existing cross-connections and ensure proper engineering measures, e.g., air gaps and back-flow prevention devices are in place and operate properly. ☛ The Cross-Connection Control Manual, EPA-570/9-89-007, contains excellent information on testing procedures, methods, and devices to prevent backflow and administering a cross-connection control program. ☛ Backflow Preventers, Reduced Pressure Principle Type, NAVFACINST 11330.11 (series), contains a list of backflow prevention devices approved for use at Coast Guard shore facilities. ☛ Enclosure (4) defines terms used in this chapter.

2. Shore Piping System Color-Coding.

   a. Paint potable water piping, including valve bodies, to match surrounding areas and identify the piping to indicate contents as described in the ☛ Coast Guard Colors and Coatings Manual, COMDTINST M10360.3A (series), Chapter 14.B.6 a. and b.

   b. As described in the ☛ Coast Guard Colors and Coatings Manual, Chapter 14.B.6 a., paint potable water valve handles, valve handwheels, and levers dark blue (Fed Std 595, Color Number 15044).

   c. Leave potable water valve packing glands, valve stems, threads, and other similar working surfaces unpainted.

C. Water Main Flushing and Disinfection.

1. Computing Water Volume. The chlorine dosage needed to disinfect any unit depends on the contact time and organic, chlorine-consuming material present. To estimate chlorine dosage, first compute the volume of water in the unit to be disinfected. Table 2.1. lists volumes of water contained in different sizes of pipe.

Table 2.1.: Volume of Water in Different Sizes of Pipe

Pipe Diameter (Inches)	Gallons per Foot of Pipe
2	0.16
2.5	0.26
3	0.37
3.5	0.5
4	0.66
6	1.5

8	2.62
10	4.1
12	5.9
14	8.04
16	10.5

1. D^2 x 0.041 = gallons per foot of pipe or foot depth in a round tank. D = diameter of pipe or round tank in inches.
2. One cubic foot of water = 7.48 U.S. gallons
3. One U.S. gallon = 8.34 pounds
4. One U.S. gallon = 3,785 ml

2. Water Main Flushing. Public works or maintenance personnel must make sure to clean and flush all new or repaired mains and extensions with potable water before disinfecting them and placing them into service. Flushing at a velocity of at least 3 feet per second clears all dirt, mud, and debris from new or repaired mains.

3. Disinfecting New, Repaired, or Accidentally Polluted Water Mains.

   a. After determining the number of gallons of water the component or system now or will contain, find the correct calcium hypochlorite (65-70 percent available chlorine) or sodium hypochlorite (5-10 percent available chlorine) dosage in ☛ Enclosure (2), the Chlorine Dosage Calculator, which lists the approximate dosage of chemicals needed to achieve the desired disinfecting FAC residual. Check these residuals with the DPD colorimetric procedure.

   b. When portable gas chlorinators are used to disinfect mains, tanks, or other units, the MDR must consult the operator's instruction manual. The desired disinfecting residuals must be checked with the DPD colorimetric procedure.

   c. Table 2.2. lists acceptable residuals and specifies contact times for disinfecting water mains, tanks, and other appurtenances providing they are first cleaned and flushed with potable water as described above.

Table 2.2.: Water Main Disinfecting Specifications

Initial FAC (ppm)	Contact Time	FAC (ppm) After Required Contact Time
50	24 hours	25
500	30 minutes	500
100	4 hours	50

4. Swabbing Repair Pipe Lengths and Fittings. Before installing, besides the flushing and disinfecting procedures described above, swab the interior of all repair pipe lengths and fittings with 5 percent chlorine solution (50,000 ppm) to make sure the residue in the

joints and fittings is oxidized. After completing repairs, flush the repaired section and disinfect as discussed above.

5. Post-Disinfection Flushing and Microbiological Analysis. Regardless of the method used to disinfect new or repaired mains, concentrated chlorine solutions must be flushed from the line after completing disinfection. The MDR must collect samples downflow from the affected pipe length or on both sides of the length if the direction of flow varies or is unknown and then check samples for microbiological contamination to ensure disinfection has been adequate. If the appropriate microbiological test results show adequate disinfection, the new or repaired main can be returned to service.

6. Pressure.

   a. Engineering personnel must design water distribution systems to provide an acceptable operating pressure in distribution mains, building service connections, and within buildings. Areas on high ground or needing high pressure must have a separate high-service system pump, backed by elevated storage where possible, to maintain pressure.

   b. Every distribution system main must be at least 6 inches in diameter or use 4-inch or smaller mains only after obtaining the cognizant Civil Engineering Unit's (CEU) approval. Within these constraints select the smallest pipe satisfying these conditions:

      (1) Supports at least 20 pounds per square inch residual pressure at all hydrants.

      (2) Supports residual pressure to meet automatic fire extinguishing systems' needs. The main must sustain 50 percent of the average domestic and industrial flows simultaneously with 100 percent of the fire flow.

7. Using Non-potable Water. Engineering personnel must design non-potable distribution systems using coupling devices incompatible with potable systems' to prevent interconnection. Also, the marking NON-POTABLE must be stenciled on non-potable distribution systems to identify them. On shore stations, color-code pipes to distinguish potable from non-potable systems.

D. Potable Water Storage.

1. Background. Potable water distribution reservoirs are necessary to fight fires, satisfy peak demands, support uniform water pressure, meet industrial needs, and avoid continuous pumping. Storage tanks enable pumps to operate during periods of low electrical use rates. Locating water storage tanks close to the supply source allows the most economical pipe sizes and pumping capacities.

2. Maintenance.

   a. Coatings. To operate a distribution system efficiently it is crucial to inspect, maintain, and repair storage tanks. Corrosion and scaling in storage tanks may adversely affect the quality of the stored water and ultimately cause the tank structure to fail. All tank coatings, including sealing compounds and other materials, must meet ☛ NSF Standard No. 61 or the state having primacy's standards for contact with and in potable water. The Engineering Department shall paint the interior of potable water tanks with an epoxy coating to comply with ☛ the Coast Guard Colors and Coatings Manual, COMDTINST M10360.3A (series), Chapter 15, Table 11. Color-code potable water storage tanks' exterior green with large yellow letters to comply with the ☛ Coast Guard Colors and Coatings Manual, COMDTINST M10360.3A, Chapter 14-A. ☛ AWWA Standards D102-78 and D101-53 contain more information on inspecting, painting, and repairing tanks, standpipes, and reservoirs. Table 2.3. lists the standard color-coding schemes for potable and non-potable water systems.

Table 2.3.: Color Codes for Shore-to-Ship Water Connections

Potable Water	Dark Blue
Water Provided for Fire Protection	Red
Chilled Water	Striped Blue and White
Oily Wastewater	Striped Yellow and Black
Sewer	Gold

   b. Distance. Engineering personnel must physically separate non-potable systems from all potable water distribution systems. Whenever possible, Engineering personnel will implement precautions, e.g., removing control valves, so only authorized personnel can operate the non-potable system.

   c. Non-Potable Water Uses. Use non-potable fresh or salt water for fire protection, flushing, and industrial uses only if the potable supply is insufficient for all requirements. Using non-potable water for personal hygiene, e.g., laundering, showering, and bathing, is prohibited for Coast Guard shore facilities.

3. Sanitary Standards for Water Storage.

   a. Potable Water Tanks Below Ground Level:

      (1) Engineering personnel must locate overflows, e.g., workhole covers and vents, with their tops 6 inches above grade.

      (2) The bottom of the tank must be higher than the water table or flood water; design for a minimum depth of 8 feet.

      (3) The ground around the tank must slope away from the tank to drain properly.

(4) Engineering personnel must locate tanks higher than any sewers or sewage disposal systems.

(5) Engineering personnel must locate sewers or sewage disposal systems at least 50 feet from water storage tanks.

b. All Potable Water Tanks:

(1) Covers. Potable water storage tanks must be covered to prevent contamination by dust, rain, insects, animals, and birds and discourage algae growth. Screen all vents and overflows with 20-mesh bronze insect screens. Rain-proof vents with goosenecks or vent caps. Workhole construction and location must minimize the possibility of contamination. Design workholes (roof hatch) with a coaming or curb 2 to 6 inches high around the opening; workhole covers must overlap this coaming by at least 2 inches. Except when in actual use, lock workhole covers. Do not connect overflow and drain pipes directly to sewers.

(2) Safety Precautions. Workers must take safety precautions before entering a storage tank to prevent accidents due to oxygen-deficient atmospheres or harmful concentrations of toxic or explosive gases or vapors. Workers must consult ☛ 29 CFR 146, COMDTINST 5100.48 (series), or other local instructions for correct entry procedures. The ISC Safety and Environmental Health Officer can outline entry procedures, specify respirators, and recommend other safety equipment necessary for tank (confined space) entry and work; supervisors should contact this Officer for safety information on working in tanks and other confined spaces. Workers must use ladders with approved safety cages on all elevated storage tanks to comply with ☛ 29 CFR 1910.27. Install a wire fence and locked gate around storage tanks to prevent unauthorized entrance.

4. Disinfecting Water Storage Tanks. Before putting new, rehabilitated, or repaired potable water tanks into service or when entering tanks for inspection or any other reason, Engineering personnel must disinfect the tanks. Engineering personnel also will disinfect tanks when bacteriological evidence shows the tank has become contaminated. At units with limited water supplies, to conserve water Engineering personnel may scrub storage tanks' interior surfaces with 500 ppm chlorine solution, a concentration that disinfects almost immediately. After complete application, flush all surfaces with potable water. Supervisors must coordinate this operation with facility medical personnel; entry and work must follow procedures described in Item (2) above.

E. Water Treatment.

A safe, dependable water supply greatly enhances members' physical and mental well-being. Like many other natural resources, water is procured as a raw material, manufactured into a commodity suitable for use, and distributed for consumption. Unit EOs must evaluate each water source individually to determine the needed treatment type and degree. Disinfection is a must for all water used for drinking and alone may suffice for a deep well. Sedimentation, coagulation, flocculation, filtration, and disinfection usually are needed for most surface sources. The CO is responsible for ensuring the water supply is safe, palatable, and at a minimum meets or exceeds all applicable NPDWR and state water quality standards.

1. Disinfecting Potable Water.

   a. Disinfectant Criteria. The disinfectant must:

      (1) Mix uniformly to provide intimate contact with microbial populations potentially present.

      (2) Maintain a wide range of efficacy to account for expected changes in treatment conditions or in the characteristics of the treated water.

      (3) Be safe for human consumption at the concentration levels present in the finished water.

      (4) Maintain enough residual to protect the distribution system from microbial growth and indicate contamination after initial disinfection.

      (5) Be readily measured in water in the prescribed concentrations effective for disinfection.

      (6) Destroy virtually all disease-producing microorganisms.

      (7) Be practical to use and store.

   b. Chlorination. Under normal operating conditions, chlorination is the most widely used procedure to routinely disinfect water. These variables affect chlorine's efficiency:

      (1) The form, type, and concentrations of chlorine used.

      (2) The pH of the water. At 72° F (22° C) and pH 6.5, 0.3 ppm of combined residual causes a 100 percent bacterial kill within 60 minutes. At the same temperature and time, at pH 7.0 the combined residual must be 0.6 ppm to be as effective. Table 2.4. presents this pH-chlorine residual relationship.

      (3) The type and density of organisms—bacteria, viruses, protozoa, helminths, or others—present. Of all the waterborne diseases, chlorine disinfection most easily prevents those caused by bacteria. At the other extreme, certain pathogenic organisms, e.g., cysts of the protozoa *E. histolytica* and *Giardia lamblia*, are the most resistant. Health authorities may recommend increasing the chlorine residual to destroy chlorine-resistant pathogens if they are present in the water supply. Check with the area MLC (kse) for more information.

      (4) The contact time of the organisms with the chlorine.

(5) Water temperature. At lower temperatures, higher residuals are needed because bacteria tend to die slower, an effect more noticeable with combined chlorine than free available chlorine.

(6) The concentration of other substances exerting demands on the chlorine. During disinfection, chemical compounds including those containing ammonia and the whole spectrum of organics can exert chlorine demand. Conventional water treatment processes do not effectively remove many of these compounds.

(7) Mixing chlorine and chlorine-demanding substances. The agent must be well dispersed and homogeneously mixed to assure the disinfection contact time is uniform throughout the water supply.

(8) ☛ The Manual of Naval Preventive Medicine, NAVMED P5010, Chapter 5, Appendix D, contains standards for operating chlorination facilities safely.

Table 2.4. Chlorine-pH Relationship to Kill 100 Percent of Bacteria in 60 Minutes (at 72° F)

pH	Combined Chlorine (ppm)
6.5	0.3
7.0	0.6
7.7	0.9
8.0	1.0
8.5	1.2
9.5	1.5
10.5	1.8

c. <u>Chlorine Residual</u>. All potable water distribution system points must maintain a measurable FAC or combined chlorine residual. This applies to Coast Guard-owned and -operated supplies from ground and surface sources but not to water supplied directly to facilities, leased buildings, or like facilities by a public water supply distribution system or by a bottled water supplier approved by the State or host nation's health authority. If approved municipal water supplied to a facility does not have a measurable FAC or combined chlorine residual, the MDR should consider this when devising the microbiological monitoring program. These are important points to consider:

(1) Coordination between the Engineering Officer and ISC Safety and Environmental Health Officer or Medical Department Representative is essential in this situation.

(2) If an unhealthful situation exists the Medical and Engineering Departments must consider installing a chlorination system for the supplied water. Some disinfectants or chemicals added to purchased water are incompatible with those a supplier uses;

e.g., adding enough chlorine to produce FAC to water disinfected with combined chlorine (chloramine) may result in water exceeding the trihalomethane maximum contaminant level (MCL). Hence, the supplier and state or EPA authorities must approve chemicals added to bought water. Rechlorinating or adding other chemicals to purchased water could change the system's EPA or state classification and require compliance with the state regulating authority. Always consult the area MLC (kse) or state authorities before altering the water supply in any way.

(3) In a primacy state state regulatory authorities or in a non-primacy state regional EPA officials finally interpret whether an installation qualifies as a water supplier.

d. Chlorinating Problem Systems. Chlorinate water from systems where sanitary, physical, or operating defects or other special hazards are known to exist or where microbiological examinations show rechlorination is necessary to achieve satisfactory quality to bactericidal levels shown in Table 2.5.

Table 2.5 Recommended Minimum Free and Combined Bactericidal Chlorine Residual in Case of Water System Problems

pH Value	Minimum concentration of free chlorine residual after 10 minutes, ppm (mg/L)	Minimum concentration of combined chlorine residual after 60 minutes, ppm (mg/L)
6.0	0.2	1.0
7.0	0.2	1.5
8.0	0.4	1.8
9.0	0.8	Not applicable
10.0	0.8	Not applicable

e. Health Effects of Chlorination. The EPA is concerned about the health effects of chlorinated organics, so the NPDWR lists maximum contaminant levels (MCLs) of trihalomethanes (THMs). Commonly found in chlorinated drinking water, particularly that obtained from surface water sources, THMs form when naturally occurring organic substances react with chlorine during drinking water treatment and distribution. Chlorination methods may dramatically affect the resultant THM level. At a minimum, facilities obtaining their raw water from surface sources and practicing pre- and post-chlorination must practice chlorination optimization. Reduce pre-chlorination doses to the lowest level needed to maintain a trace chlorine residual through the treatment system before post-chlorination. Then post-chlorinate to achieve needed chlorine residuals in the distribution system. This technique uses chlorine most effectively while minimizing THM formation. Potable water transferred from shore to ship normally contains a trace of FAC; still, some ships may receive shore water disinfected with chloramine. If so, the MDR may contact the area MLC for testing, treating, and monitoring instructions.

f. Determining Chlorine Residuals. Both FAC and combined chlorine residuals apply at United States and overseas facilities. Determine residual FAC by using the diethyl-p-phenylene diamine (DPD) or other EPA-approved method that specifically measures FAC. Determine combined chlorine residuals by using tests that give the total chlorine present from which the free component can be subtracted.

g. Chlorination Methods.

(1) Marginal Chlorination. Marginal chlorination satisfies the initial chlorine demand but some oxidizable substances remain.

(2) Superchlorination and Dechlorination. In this procedure, apply stronger chlorine concentrations than needed to achieve acceptable bactericidal efficiency to control taste- or odor-producing substances and bacteria. Before the water enters the distribution system remove surplus chlorine by dechlorination with sulfur dioxide, aeration, or activated carbon.

(3) Break-Point Chlorination. Apply enough chlorine to produce a chlorine residual composed of predominantly FAC with little or no combined chlorine present.

(4) Chloramines (Combined Chlorine and Ammonia). Depending on the population served, EPA has established a maximum contaminant level (MCL) of 0.10 mg/1 for trihalomethanes. Some raw water contains natural organic substances (precursors) that react with chlorine to form THM. When disinfecting water containing precursors with chloramines rather than free available chlorine, THM formation may be delayed until the water is used. Requiring a longer contact time to achieve complete disinfection, chloramines disinfect less effectively than free available chlorine. Specific chloramine disinfection techniques, e.g., the ratio of ammonia and chlorine or the treatment steps at which to add chlorine and ammonia, are designed for the water being treated. The state or EPA regional office must approve all proposed treatment processes to remove THM.

h. Sampling for Halogen Residuals. For Coast Guard-owned water systems, see ☛ section 2-H, personnel responsible for potable water systems must be sure to maintain proper chlorine levels by frequent, regular chlorine analysis, both at the point of application and various points in the water distribution system. Test treated water for chlorine residual before distribution at least daily and more often if the character and variability of the water supply dictates. See ☛ section Chapter 1, section 1-J-4.c, for chlorine test procedures. In addition, the MDR must test for chlorine residuals when taking microbiological monitoring samples. See ☛ Chapter 3. Always run a pH test whenever testing for chlorine. Enter and maintain this information on a log. The Potable Water Quality Log found at Appendix 1.A is designed for shipboard use but can be adapted and used for ashore potable water systems.

i. Other Methods. At present, chlorination is the only authorized method to disinfect potable water at Coast Guard ashore units. Requests to for Coast Guard units to use a method of disinfection other than chlorination must be approved in writing by the MLC (kse).

2. Fluoridation. Fluorides are a small but important element in the human diet. Food supplies part of the requirement, but the greatest portion comes from the potable water supply. Applying fluoride to water supplies is recommended if the water's natural fluoride content is too low to prevent dental caries, i.e., cavities, in children. The NPDWR establishes the maximum contaminant fluoride level; ☛ Enclosure (1) for maximum contaminants. If public water system levels exceed NPDWR, the Engineering Department must install control methods. Although fluorides taken internally in recommended concentrations help prevent cavities, excessive amounts may produce objectionable dental fluorosis (mottled tooth enamel), which increases in severity as the fluoride concentration surpasses the NPDWR maximum contaminant level.

3. Corrosion Control. Corrosion—a metal's reversion to its native stable state as an oxide—is a phenomenon associated with a metal and the water in a distribution system. In water distribution systems corrosion is a natural, two-phase process. In the first the metal dissolves in the water; in the second the dissolved metal's oxide deposits itself at the corrosion site. Water supplies contain different minerals and gases. Some waters, called corrosive waters, promote the solution of metal more rapidly than others and some waters, called non-corrosive or protective, promote formation of a mineral or oxide layer that protects against continued corrosion. Physical factors affecting corrosion and corrosion control are temperature, velocity of water moving over the metal, changes in flow direction and velocity, and contact with a second metal or nonmetal. Correlations among pH, temperature, alkalinity, hardness, and total dissolved solids in the water to determine its relative corrosiveness have been developed.

   a. Corrosion results from electric current flowing between two electrodes, an anode and a cathode, on the metal surface. These areas may be microscopic and in close proximity, causing general, uniform corrosion and often red water, or they may be large and somewhat distant from each other, causing pitting with or without tuberculation, i.e., creation of small, knobby prominences. Various conditions, some due to metal characteristics and some to water characteristics at the boundary surface, may induce electrode areas.

   b. Several facilities practice chemical corrosion control to increase the distribution system's longevity. Protective corrosion-control measures include using different alloys in pipe manufacture, using protective coatings in a new main installation, and in-place coatings or linings after cleaning mains. Chemical control supplements protective control but does not substitute for it, nor can chemical control overcome improper flow conditions, poor design, defective materials, and faulty coatings. Polyphosphates and silicates are routinely used for chemical corrosion control.

Consult ☛ American Water Works Association (AWWA) Standard 10008 for a detailed discussion of corrosion control.

(1) Polyphosphates reportedly are effective in reducing corrosion in domestic waters but potable water system specialists must evaluate their potential effectiveness individually. Polyphosphates also may cause substantial phosphorus loading in receiving wastewater treatment facilities.

(2) Silicates are popular for chemical corrosion control in waters of low hardness or alkalinity.

4. Emergency Treatment. Special situations, i.e., disasters and overseas travel, may warrant emergency disinfecting of water supplies prior to consumption. The most effective treatment to destroy harmful microorganisms is to bring water to a rolling boil for at least one minute. Maintain the boil for an additional 3-5 minutes if located at high altitudes. Chemical disinfectants such as iodine or chlorine tablets or drops are effective against many microorganisms but are not reliable for killing Giardia cysts and Cryptosporidium oocysts. Add 8 drops of liquid household bleach or 20 drops of tincture of iodine per gallon of water and let stand for 30 minutes. Double the concentration if the water is cloudy. Iodine and chlorine tablets are commercially available – use according to instructions. A far less reliable method is portable water filters. Consult with area MLC(kse) prior to use. All portable water filters must meet ☛ANSI/NSF International Standard #53 for cyst removal.

F. Water Quality Standards.

Water's suitability for any given use is determined by its quality in terms of its physical, chemical, radiological, and microbiological constituents. Water acceptable for human consumption must be palatable, and, more importantly, free of any constituents that would adversely affect physical well-being. Also, it must not degrade the materials that transport and store it. Potable water also must be suitable for the ancillary uses associated with human habitation, e.g., personal hygiene, laundering clothes, dishwashing. Setting drinking water quality standards establishes a basis to select or reject a water supply intended for human consumption. The standards are maximum values and commands must make every reasonable attempt to obtain better-quality water. Only a qualified professional such as a safety and environmental health officer may interpret water quality data.

1. Treated Water Standards. Water intended for human consumption must be of the highest quality. Maximum Contaminant Level (MCL) standards for treated water state the maximum values of various constituents that may be present in drinking water. For MCLs, ☛ Enclosure (1).

2. Physical Quality. The principal physical characteristics of water are color, odor, turbidity, and temperature. The basis for physical quality standards primarily depends on consumer acceptance. If water's physical characteristics exceed ☛ Enclosure (1) limits, it generally

is not used for drinking. When local conditions require using water of lower physical quality, the Engineering Department must obtain the MDR's concurrence. Note: If water quality does not meet NPDWR standards, the command also must coordinate with regulatory authorities.

3. Chemical Quality.

   a. The chemical quality of water, determined by all the chemical constituents present and any interactions among them, may be described in terms of inclusive characteristics, e.g., total hardness, alkalinity, and pH, or of a particular cation or anion, e.g., arsenic, barium, or calcium.

   b. The EPA has established chemical water quality standards based on the physiological impact and attendant affect the water will have on humans and consumers' response to its palatability or utility. A particular chemical's affect or an inclusive characteristic of chemical quality will determine whether the EPA sets a mandatory or desirable limit for that chemical. Chemical constituents causing harmful physiological effects must have a mandatory limit the water cannot exceed under any circumstances. Other constituents, e.g., iron and manganese, have no significant adverse physiological effect but may cause hardness and restrict the water's utility for laundering clothes. These constituents normally have a desirable limit the water cannot exceed unless better-quality water is unavailable. ☛ Enclosure (1) for potable water chemical water quality standards.

   c. Pesticides are toxic and must be properly stored, handled, and used to achieve the desired results without creating unwanted toxic hazards and environmental contamination. Their persistence in the environment makes it necessary for the EPA to limit the concentrations of these pesticides in drinking water. ☛ Enclosure (1) for reference limits.

4. Microbiological Quality.

   a. The microbiological quality of drinking water indicates its potential to transmit waterborne diseases, which may be caused by viruses, bacteria, protozoa, or higher organisms. Microbiological examinations reveal the quality of the raw water source, aid in deciding the treatment needed, and so are essential to keeping the water quality within established potability standards. Directly measuring pathogenic organisms in a water sample is extremely difficult. Even in a badly polluted water supply, these organisms' density is usually very low, and the analytical techniques used to identify them complex. Therefore, indicator organisms are used to show the presence of fecal contamination in a water supply. The most common organisms indicating possible contamination are coliform group bacteria, e.g., *Escherichia coli*, *Klebsiella pneumoniae*, and *Enterobacter aerogenes*. Occurring in large quantities in warm-blooded animals' intestines, these bacteria in water are presumptive evidence of fecal contamination. Particularly in low densities, their presence does not always mean human fecal contamination has occurred, but the presence of any coliform organism in treated drinking water is a sign of either inadequate treatment or the introduction of undesirable materials to the water after treatment.

b. The normal habitat of fecal streptococci is humans' and animals' intestines; thus these organisms can indicate fecal pollution. The MDR usually conducts microbiological examinations of potable water to show either the presence or absence of the coliform group. The Autoanalysis Colilert Test (Colilert Test) and the Membrane Filter (MF) Technique satisfy the NPDWR.

(1) Colilert Test. Its relative simplicity has earned the Colilert Test wide acceptance throughout the military as the preferred technique to identify coliform organisms in drinking water. The Test is based on coliform bacteria's ability to produce the enzyme beta-galactosidase, which hydrolyzes o-nitrophenyl-beta-d-glactopyranoside (ONPG) present in the chemically defined medium to form a yellow color within 24 hours, while the test medium formulation suppresses the growth of non-coliform microorganisms. As stated in ☛ *Standard Methods for the Examination of Water and Wastewater*, current edition, the Colilert Test may be used except for units located in a primacy state mandating the multiple tube fermentation technique. ☛ Chapter 3 for the Colilert Test procedure.

(2) Membrane Filter Technique. As described in ☛ *Standard Methods for the Examination of Water and Wastewater*, current edition, the Membrane Filter (MF) technique is the alternate test to detect coliform bacteria, except for units located in a primacy state that mandates the multiple tube fermentation technique. The membrane filter technique differentiates coliforms from warm-blooded animals and those from other sources with 93 percent accuracy. Membrane filter methods also identify fecal streptococcal group organisms. ☛ Chapter 3 describes the MF test procedure.

(3) Multiple Tube Fermentation Technique. The current ☛ *Standard Methods for the Examination of Water and Wastewater* states this test may be used when large amounts of suspended solids in the sample prohibit using the Colilert Test or Membrane Filter Technique.

(4) Standard Plate Count. This test gives the number of bacteria that can grow under test conditions. Although the NPDWR does not direct using the standard plate count, its use may be needed for comparative purposes under known or controlled conditions to show changes from the norm and determine whether follow-up investigation and action are indicated. The plating must be completed within 6 hours after collecting the sample or results may be inaccurate. The test is valuable in finding the microbiological efficiency of a water treatment process's various units. Excessively high counts may indicate serious contamination in the system and warrant further investigation.

(5) Other methods, the fecal coliform and fecal strep techniques being the two most common, more specifically identify the origin of bacteriological contamination. Specific testing procedures such as these are recommended for drinking water if more generalized tests, e.g., either the Colilert Test or Membrane Filter procedure, yield positive results. Because of these organisms' survival characteristics, other fecal indicators, e.g., fecal and total coliforms, must be used simultaneously. ☛ *Standard Methods for the Examination of Water and Wastewater* extensively discusses the microbiology of drinking water and testing methods or consult the area MLC.

5. Radiological Quality. Radioactive elements can appear in water supplies due to naturally occurring contamination, indiscriminate disposal of hospital or industrial radionuclides, or reactor leakage. Radiological water quality standards are based on the premise radiation harms humans, who should avoid any unnecessary exposure. The physiological effects associated with overexposure to radiation demand rejecting any treated water containing excess quantities of radionuclides. Proper treatment methods usually will provide drinking water of desired radiological quality. ☛ Enclosure (1) summarizes NPDWR standards for radionuclides.

G. Water Quality Monitoring.

Water quality monitoring ensures drinking water quality on Coast Guard facilities meets NPDWR and state minimum health standards, protects the distribution system from undue corrosion or scaling, and ensures the treatment plant treats water economically and thoroughly. The area MLC directs a water quality monitoring program to meet these objectives. ☛ Enclosure (1) contains treated water quality standards.

1. Environmental Sampling. To meet these goals EOs must test treated waters Coast Guard-owned or -operated facilities supply. Treated water includes any treatment of raw surface or ground water sources, including rechlorinating or fluoridating purchased water. Also, Coast Guard facilities that sell or give treated water to non-Coast Guard military authorities or civilian communities are considered water suppliers because they own or operate a public water system and therefore must perform environmental monitoring services for the areas they supply, observing the NPDWR and NSDWR as applicable. Complying with state drinking water regulations or NPDWR requires environmental monitoring. In primacy states regulatory agencies or in non-primacy states the Regional EPA office must certify the laboratories that analyze drinking water.

2. Responsibilities.

   a. The unit CO has the ultimate responsibility to conduct and fund all routine environmental sampling, analyzing, reporting to the EPA or states, and keeping NPDWR-required records.

   b. The EO normally collects samples and performs laboratory analysis.

c. The MDR must work closely with the certified laboratory, water supplier, and Federal, state, or local regulatory authority and must review analysis results and make recommendations to assure compliance with NPDWR and NSDWR. An EPA- or state-certified military or civilian laboratory must analyze all water.

3. Physical, Inorganic, Organic, and Radiological Surveillance.

a. Surface Water Sources. EOs must analyze community water systems yearly for the inorganic chemicals the NPDWR specifies. Analyze community water systems for specified organic chemicals, excluding trihalomethanes, as often as the state specifies or at least once every three (3) years. Monitor trihalomethanes quarterly as primacy states or the EPA direct. For community water systems, analyze for radiological activity at least once every four (4) years. A state bases compliance by analyzing an annual composite of four consecutive quarterly samples. Once an acceptable database is available, the state may modify the sampling regimen. Likewise, if cause for concern exists, the state may require more stringent monitoring. EOs must analyze water for man-made radioactivity in systems serving more than 100,000 persons or those the state specifies. This portion of the NPDWR does not affect Coast Guard systems; but EOs must follow the various states' guidance and sampling mandates. Using the Nephelometric Method on a sample collected at an entry point into the distribution system, EOs for both community and non-community systems must analyze for turbidity at least once daily; ☛ *Standard Methods for the Examination of Water and Wastewater*, current edition. The states specify nitrate analysis as the only inorganic analysis for non-community systems, but may require additional analyses. States do not direct organic and radiological analyses for non-community systems.

b. Ground Water Sources. The NPDWR directs community water systems using only ground water sources to conduct inorganic analyses at least every third year; for natural radioactive substances as specified for surface water sources; and for man-made radioactive substances as the state specifies. EOs must analyze ground water supplied to non-community systems for nitrates as the state specifies. EOs need not monitor ground water sources for turbidity.

4. Environmental Monitoring. For community water systems, EOs will collect the same number of samples from the unit distribution systems as the NPDWR requires for the population served. For non-community water systems, EOs must collect at least one microbiological sample per month unless state mandate directs more.

5. Supporting Laboratories. State- or EPA-certified laboratories must analyze samples from U.S. public water systems. Anyone acceptable to the state can measure for turbidity and free chlorine residual. Obtain technical help for radionuclide analysis from the USAF Occupational and Environmental Health Laboratory, Brooks Air Force Base, Texas and the U.S. Army Center for Health Promotion and Preventive Medicine, Aberdeen Proving

Grounds, Maryland. Use these services only if state-certified laboratories are not available and first obtain approval to do so from the area MLC.

H. Coast Guard-Owned Water Systems.

1. Definition. A Coast Guard-owned water system is a public water system (☛see Enclosure 4 for definition), and meets at least one of these criteria:

    a. Treats raw surface or groundwater, or

    b. Stores water, or

    c. Rechlorinates, flouridates or applies corrosion control to municipal water.

2. Responsibilities.

    a. The unit CO is responsible for funding and ensuring compliance with the NPDWR by establishing a surveillance program; see ☛ Appendix 2.C.

    b. Normally the EO actually collects and submits samples. For community water systems, see definitions, ☛see Enclosure 4 for definition, prepare and distribute consumer confidence reports annually. ☛Refer to Federal Register, 19 August 1998 (Volume 63, Number 160), for details.

    c. The MDR must routinely review monitoring results to ensure the water meets all NPDWR or corresponding state drinking water regulations.

I. Purchased Water, e.g., Public Water Systems.

1. Scope of NPDWR and NSDWR. The NPDWR and NSDWR apply to Coast Guard-purchased water under these circumstances:

    a. The system has collection and treatment facilities.

    b. The Coast Guard obtains the water from a system to which NPDWR and NSDWR do not apply.

    c. The Coast Guard sells the water for potable use.

    d. Water from Coast Guard sources supplements the purchased water.

    e. The Coast Guard treats the water, e.g., rechlorinates, fluoridates, or adds corrosion control chemicals.

    f. States with primacy or in non-primacy states the EPA Regional Office finally classify a unit as a "supplier of water". If either entity finally determines a unit that purchases its potable water is a "supplier of water", that unit must comply with NPDWR and NSDWR requirements, which specify suppliers of water must conduct physical, inorganic, organic, radiological, and microbiological monitoring of the water system.

2. Environmental Sampling Responsibility. The MDR must ensure the water supplier fulfills NPDWR and NSDWR requirements. Independent analyses are not needed for physical, chemical, microbiological, and radiological contaminants if the MDR is satisfied the supplier is fulfilling Federal, state and local mandates.

3. Bottled Water. Bottled water, a type of purchased water, must comply with all applicable state regulations and NPDWR requirements for physical, chemical, bacteriological, and radiological contaminants. In addition, bottling facilities must conform to FDA standards (21 CFR parts 110, 129 and 165) and be a member of the International Bottled Water Association. Bottling facilities, which belong to the International Bottled Water Association, receive third-party compliance inspections. The MDR must verify bottled water quality and approve purchasing it for distribution at a unit from a medical perspective. When procuring and storing bottled drinking water for disaster preparedness, the MDR must institute a semiannual microbiological monitoring program. Units may elect to procure bottled water with unit funds if a written determination has been issued by the area MLC (kse) that the product water fails to meet state standards or current NPDWR or is unsafe for any reason. Recent NPDWR is found at ☛ Enclosure (1) of this manual.

J. Environmental Sampling Overseas.

All overseas Coast Guard facilities must maintain the same drinking water standards as CONUS units do. Submit all requests to deviate from CONUS drinking water standards in writing to the area MLC.

K. Military-Unique Chemicals and Other Potentially Hazardous Materials.

If a unit CO suspects military-unique chemicals or other potentially hazardous materials have contaminated a water source, he or she must immediately consult the area MLC, which can arrange analysis from laboratories capable of performing the necessary tests.

L. Operational Environmental Monitoring.

Besides the environmental sampling program previously mentioned, to provide quality control for any treatment processes used, water treatment personnel must collect additional samples for tests such as coagulant demand, turbidity, color, odor, chlorine residual, fluoride, iron, manganese, pH, temperature, hardness, total alkalinity, and total dissolved solids. The last five analyses mentioned determine the Langlier Index, which indicates corrosive properties of treated water. Take operational samples as often as necessary to maintain effective treatment control and reduce treatment costs.

M. Sampling and Preservation Procedures.

1. Physical, Inorganic, Organic, and Radiological Surveillance. Facilities having public water systems must follow NPDWR and NSDWR sampling and sample preservation guidelines or corresponding state drinking water regulations. Facilities without public

water systems must observe sampling and preservation guidelines identical to NPDWR and NSDWR guidelines or corresponding state regulations and shall contact the laboratory to verify laboratory capability, appropriateness of the analytical request, sampling techniques, and sample preservation guidelines.

2. Microbiological Sampling. Generally, ☛ Chapter 3 lists the sampling techniques to determine water's microbiological quality. Analyze samples collected for microbiological analysis as soon as possible after collection, ideally within 6 hours, except for samples mailed from distant units, which may be held for up to 30 hours. Samples must be shipped in ice because extensive changes take place in bacterial flora in samples stored at temperatures even as low as 4° C.

3. Sampling Location Plan. The MDR must keep a map of the unit water distribution system showing all sampling points. When evaluating potability, use only water samples distributed for drinking and cooking purposes. Choose sampling points to represent principal use, e.g., dining facilities, hospitals, barracks, and residential and administrative areas. Spot-check but do not routinely monitor hot water faucets, leaking mixing faucets, drinking fountains, fire hydrants, or outlets connected to dead-end sections of the distribution system. Facilities using two or more independent distribution systems must consider each system as separate and distinct for calculating the number and frequency of samples to be drawn.

4. Analytical Methodology.

   a. Physical, Inorganic, Organic and Radiological Surveillance. The NPDWR, NSDWR, and corresponding state drinking water regulations contain analytical methods for monitoring public water systems. For other types of monitoring, see ☛ *Standard Methods for the Examination of Water and Wastewater,* current edition.

   b. Microbiological Monitoring. For units having public water systems, NPDWR or corresponding state drinking water regulations contain approved analytical methods. The MF and Colilert Test, using a standard sample of 100 ml of finished water, are approved methods. Unless located in states requiring another approved total coliform test, Coast Guard units may use the Colilert Test with a standard sample volume of 100 ml, due to ease. Use the Colilert Test technique for other types of monitoring not governed by drinking water regulations.

N. Reporting and Record-Keeping.

1. The NPDWR directs public water system operators to give the regulatory agency chemical and microbiological results within 40 days after analysis. The Engineering Department must keep microbiological analysis records for 5 years and chemical analysis records for 10 years. Other sample collection information and laboratory analyses also must be kept. See the ☛ NPDWR, subpart D, or corresponding state regulations for complete reporting and record-keeping details.

2. Units not receiving their potable water from an approved municipal source, providing on-base treatment, or storing water for later distribution must submit copies of all monitoring results to their servicing Integrated Support Command (ks) for review.

O. Remedial Action.

1. Suspected Bacteriologic Contamination. ☛Appendix 3.A. presents information on what the command should do if it suspects bacteriological contamination. If testing reveals coliform-positive samples and the required follow-up samples also are positive, then consult with the area MLC. Specialized testing to indicate the source of contamination may be required.

2. Non-compliance with NPDWR (NSDWR for Fluoride). If the EO confirms a particular sampling point violates the standards listed in ☛ Enclosure (1), the CO will:

   a. Per NPDWR, notify the state or EPA and all persons the community water system serves.

   b. Provide alternate drinking water or individual treatment options until the supply is again known to be safe.

   c. Under NPDWR units operating public water systems have a public notification requirement if water exceeds Maximum Contaminant Levels (MCLs). Such units must notify the public if they do not follow applicable testing procedures or variance or exemption schedules, if the state grants a variance or an exception, and if such units do not monitor. ☛ NPDWR, subpart D, or corresponding state drinking water regulations explain public notification in detail.

P. Contingency Planning.

Managing and operating a water supply, treatment, and distribution system are complex tasks designed to guarantee a continuous supply of high-quality water for domestic and industrial use. This section highlights the need for contingency planning that can aid a facility in maintaining an uninterrupted water supply during natural and man-made disasters. When making contingency plans, it is essential the EO and MDR coordinate to define each organization's specific responsibility. Other factors to consider include:

1. List service priorities for major areas and unit users.

2. Locate major valves and backflow prevention devices to isolate damaged areas to prevent the spread of contamination.

3. Find alternate water storage, purification, and power generation equipment; e.g., use swimming pool treatment facilities or field water treatment equipment from the Navy,

Army, and Air Force active and reserve components. Units are strongly encouraged to coordinate disaster preparedness and contingency plans with these military elements.

4. Establish procedures to raise disinfectant (chlorine) residual levels for added disinfectant capability and to notify facility residents and the work force of emergency potable water problems.

5. If storing bulk potable water, follow these procedures:

   a. Determine quantity. For drinking and personal hygiene, three gallons-per-person is the minimum daily consumption rate if located in a temperate region. Use three and one-half gallons-per-person if located in a tropical region. *Note*: Estimate does not include water that may be needed for cooking or medical purposes.

   b. Disinfect water for long term storage: Add liquid bleach that contains 5.25% sodium hypochlorite to raise the free available chlorine level to 5.00 ppm after ½ hour contact time.

   c. Use only approved storage containers. Use food-grade plastic buckets or drums. Always wash and sanitize before filling.

   d. Seal water containers tightly; label, date and store them in a cool, dark, and secure location.

   e. Inspect and monitor. Inspect supplies periodically but not less than once every six months. As part of the inspection, visually inspect container condition, measure and adjust chlorine residual and take at least one sample for coliform testing. Record inspection results in a log.

   f. Clean and sanitize containers and replace water annually in lieu of inspection. Record the date on the container label.

   g. *Note:* Deviations for storing bulk potable for emergency purposes as described above require approval from the area MLC (kse).

6. Items 1. through 5. above are not intended to be all-inclusive but list potential areas needing further individual analysis.

7. For help in developing contingency plans to cope with an emergency or disaster, consult the area MLC, ☛ AWWA Manual M19, and Appendix 2.D.

Appendix 2.A. Water Sources

A. General

1. Water Sources. Depending on local conditions, units may obtain water supplies from any of several sources, including underground sources, e.g., springs or wells, and surface sources, e.g., rivers, streams, or lakes. Most Coast Guard facilities obtain their water supply from adjacent municipal facilities.

2. Sanitary Surveys. A properly conducted, preferably annual sanitary survey of an existing supply is essential to maintain good sanitary quality and furnishes sufficient data to accept or reject an existing or potential water source. Environmental Engineers and Health Officers may conduct a sanitary survey of a new source in conjunction with collecting initial engineering data on developing the source. Chemical and bacteriological analyses and knowledge of the significance of the factors involved supplement the sanitary survey.

3. Field Sources. Many units have isolated water sources, e.g., wells and springs, which often do not serve residents and therefore are not classified as public water systems. Water systems meeting these criteria are classified as field sources.

B. Wells

1. Description. Groundwater occurs in geologic formations called aquifers. Made of saturated permeable material that yields water to wells and springs, an aquifer transmits, stores, and transports water under a hydraulic or pressure gradient from recharge areas to water-collecting areas. When available, groundwater usually is an excellent water supply source. Ordinarily such water is clear, cool, colorless, quite uniform in character, and generally of better microbiological quality with much less organic material than surface water, but groundwater may contain more minerals. At present, wells serve small- to medium-sized installations, although a system of several wells may supply water for a large installation. See the American Water Works Association (AWWA) ☛ *Standard for Deep Wells*, Standard A-100-66, for more information.

2. Classification. Wells are classified according to the construction method, e.g., dug, bored, driven, drilled, and jetted. See AWWA's ☛ *Standard for Water Wells*, Standard A-100-90, describes well types, design considerations, and optimum uses. Engineers must take proper sanitary measures to ensure the water purity whenever groundwater from a well is pumped for human consumption. Potential sources of contamination may exist either above or below ground level. Where possible, construct wells on ground higher than a potential contamination source. The area must be well-drained to divert surface waters from the well and reduce the possibility of flooding. Environmental engineers must follow these guidelines for the sanitary protection of wells:

   a. Fill the annular (ring-shaped) space outside the casing with water-tight cement grout as the EPA's ☛ *Manual of Individual Water Supply Systems* requires.

b. For artesian aquifers, seal the casing into the overlying impermeable formation(s) to retain the artesian pressure.

c. When a water-bearing formation containing poor-quality water is penetrated, seal off that formation to prevent its water from infiltrating into the well and developed aquifer.

d. Every well must have an overlapping watertight cover at the top of the casing or a raised pipe sleeve to prevent contaminated water or other harmful materials from entering the well.

e. Plug and properly seal all abandoned wells as Federal, state, or local authority requires to prevent contaminating the ground water formation and for safety reasons. The basic concept behind properly sealing any abandoned well is to restore the controlling geological conditions that existed before the well was drilled or constructed. If this restoration is possible, an abandoned well will not pose a physical or health hazard. See ☛ AWWA Standard A100-66 for further guidance on this subject. Table 2.A.1. lists the suggested minimum distances a well must be located from contamination sources. In many areas, various soils and rock formations may require increased distance, as may state and local health departments. Qualified persons must conduct a sanitary survey if drilling or constructing any new well if it is located near potential contamination sources. The command must contact state and local health departments in each area before constructing or drilling any new well.

Table 2.A.1.: Minimum Distance Between Wells, Springs, etc., and Various Potential Contamination Sources

POTENTIAL CONTAMINATION SOURCE	WELL, SPRING, ETC. (DISTANCE IN FEET)
Sewer Line	50
Septic Tank (Watertight)	50
Pit Privy	100
Disposal Field	150
Seepage Pit	150
Cesspool	150

3. Disinfecting Wells. Drilled, jetted, bored, and driven wells must be disinfected after construction, cleaning, or removing equipment for repair. When the well equipment is ready for operation, the well must be flushed by pumping to waste until the water is clear. Calculate the quantity of water in the well based on water depth and casing diameter. Add enough chlorine solution to obtain 100 parts per million (ppm) through a clean hose raised and lowered to all depths of the well water. Use a spray nozzle to disinfect the inside of the casing and the outside of the riser. Operate the pump until the operator can detect a distinct chlorine odor. Check the free available chlorine (FAC) residual. When

it reaches 100 ppm FAC, allow the well to stand for 24 hours; then pump to waste until the chlorine drops to approximately 1 ppm FAC. Before putting the well in service obtain water samples for bacteriological analysis and determine potability.

4. Dug Wells. After the casing or lining is completed and before covering the well, take these steps to disinfect it:

   a. Remove everything, e.g., tools, equipment, and structures, that is not part of the well.

   b. Determine the quantity of water in the well and amount of disinfecting solution needed.

   c. Scrub the casing or lining wall with a stiff broom or brush and a 100 ppm chlorine solution.

   d. Place the well cover in position and add the disinfecting solution through a clean hose raised and lowered to all depths of the well water.

   e. Wash the outside of the pump cylinder and piping as they are lowered into the well.

   f. After the pump is in place, pump the water until a distinct chlorine odor is detectable.

   g. Check the chlorine residual; when it reaches 100 ppm FAC, allow the well to stand for 24 hours.

   h. Pump the well until the chlorine residual falls to 1 ppm.

   i. Take samples for bacteriological analysis.

   j. When bacteriological analysis produces negative results, place the well in service.

C. Springs

1. Location. Springs are formed where an aquifer intersects with the ground surface or an artesian aquifer leaks through a fracture or solution zone. Contrary to popular belief, spring water is not always of good microbiological quality. Environmental Engineers and Health Officers must exercise extreme caution in developing springs. Generally, the same principles governing locating, protecting, developing, and operating wells apply to springs. When conducting a sanitary survey of a spring, also consider the factors listed above for well location.

2. Disinfecting. When used as a water source, a small catchment reservoir usually captures spring water to enclose and intercept as much of the spring as possible. Disinfect spring enclosures by scrubbing the inside of the encasement above the water line with a stiff brush or broom and 100 ppm chlorine solution. If the flow can be stopped or maintained within the encasement, determine the volume of water and add enough chlorine solution to the water to obtain a 100 ppm FAC residual in the water. Let the spring stand 24 hours and discharge to waste until the FAC residual falls to approximately 1 ppm. Take samples and place in service as described for wells. If the operator cannot stop the spring flow, continuously feed enough chlorine into the contained water in the spring encasement near the inlet to produce 100 ppm FAC for at least 24 hours in the outlet.

D. Surface Water

1. Sources. Rivers, streams, lakes, and ponds furnish surface water supplies. Use surface water only if groundwater is not economically justifiable or of inadequate quality or quantity as physical and microbiological sources contaminate surface water more easily.

2. Criteria for Selecting Surface Water. Water supply planners must consider additional factors not usually associated with groundwater sources when selecting surface water sources. When examining surface waters as potential drinking water sources, planners must exercise care and consider several inter-related factors: pollution sources, hydrological studies, proposed intake location, and the uses responsible governmental agencies have identified for the particular water source. Examine raw water quality and propose a treatment scheme that ensures applicable regulations are followed before selecting a raw water supply.

3. Recreational Uses. Some surface potable water sources have desirable recreational uses, e.g., fishing, boating, picnicking, and bathing. Do not use a surface water source for recreational purposes if the water treatment plant does not filter the water or if the only treatment provided is sedimentation resulting from reservoir storage followed by chlorination. Take care in determining what types of recreational activities, e.g., swimming, boating, etc., are suitable for these waters. Use periodic sanitary surveys to evaluate the impact of recreational uses on these water sources.

E. Rainwater

1. Qualities. Rain, including snow and ice, can serve as a potable water source, though it generally only supplements other sources. Because of its softness, i.e., lack of minerals, rainwater may be used for cooking, bathing, laundry, and in boilers, that same softness also may impair palatability. Rainwater may contain dissolved gases, dust particles, and bacteria swept from the air. In some cases, especially if usage rates are small and precipitation heavy, rainwater may be an important source of fresh water, e.g., on small islands and in isolated areas where ground water is salty and surface water inadequate. Like any water source, rainwater must be properly treated, disinfected, and handled.

2. Collection. Rainwater is collected from impervious surfaces, e.g., roofs, concrete pavement and aprons, paved catchment areas, and barren rocks. The volume obtained depends on the catchment size and rainfall amount. To estimate the volume in gallons obtainable from an impervious surface, multiply the total catchment volume in square feet by half the rainfall in inches.

3. Storage. Rainwater may be stored either above or below ground in tanks or containers. Potable water tank coatings must meet ☛ NSF Standard No. 61 or state regulations for contact with potable water. Storing rainwater in underground cisterns keeps the water cooler and more palatable and reduces evaporation. Protect storage tanks from contamination by polluted surface and ground water. Cover storage tanks and screen the vents or other openings to protect the water from dust, dirt, insects, and vermin.

4. Disinfection. The surfaces where rain collects are subject to contamination from birds, animals, dust and at ground level, human wastes. The first rain that falls during a storm flushes these substances from the surface and must be diverted to waste. Consider rainwater contaminated until treated similarly to other surface water sources, e.g., filtration, coagulation, chlorination. The treated water must conform to SDWA as EPA published in 40 CFR 141.

F. Snow and Ice

1. Water Sources. While almost any place in the Arctic is near water in one form or another during the year, providing an adequate, safe water supply for more than 50 people is likely to be a major problem. If possible, obtain water from running streams or lakes instead of melting ice or snow because melting uses large quantities of fuel. In winter, surface water points may freeze to a depth of 6 to 8 feet. The water source must be deep enough to prevent freezing to the bottom. To prevent intake freezing, build an insulated wooden box to cover the opening in the ice. If using a raw water pump, protect it with an insulated cover or build an insulated box. If treating water off-site, build a skid-mounted, heated shelter over the water intake to house raw water pumps and settling tanks. Load this water into ski-mounted water tankers and transport to the camp for treatment. If filtering water, heated buildings are needed in winter. Standard water treatment equipment needs special heating and insulation when used in subfreezing weather.

2. Hoses. Normally, water hoses may be laid directly on the snow if water in them is circulating. When the pumps stop, prevent freezing by immediately draining the water in the hoses by pitching (slating downward) them.

3. Storage. To prevent stored water from freezing, locate small tanks or open basins in heated shelters and properly insulate outside or elevated tanks.

4. Water in Winter. In winter, if water is not available, obtain it by melting snow or ice. To save fuel, use ice or the most compact snow available. Ice is preferable because it yields more water for a given volume: melted, about 1 cubic feet of ice or 5 of snow equals 1 cubic foot of water. Freshly frozen sea ice is salty, but the salt has leached out of sea ice one year old. Test freshly frozen ice for salt content: in some areas where tidal action and currents are small, a fresh water ice layer 2 to 4 feet thick lies on top of the new sea ice. Old sea ice is rounded where broken and likely to be pitted and have pools on it; its submerged portion looks bluish. Fresh sea ice is angular where broken and looks milky. Obtain small quantities of water by melting snow or ice over a heat source. Store the snow or ice to be melted just outside the shelter and bring it inside as needed. If needed, when not cooking keep pots of snow or ice on the stove to increase the water supply. The supply system has several ice and snow melters available. Most units are portable, operable indoors or outside, use gasoline or diesel fuel, and are batch units into which ice or snow is loaded manually.

5. Water in Summer. In Arctic areas during the summer, obtain and treat surface water the same as surface supplies elsewhere. A glacial stream's milky water is harmless; sedimentation will settle out most of the color. In summer, a muskeg—a resilient soil

covered with bog with a high water table—sometimes will furnish water collected by building ditches.

G. **Sea Water.** Afloat or ashore, the sea serves as a major source of drinking water. Sea water contains up to 37,000 parts per million of dissolved salts; to remove them, process sea water in reverse osmosis water purification units (ROWPUs) or distillation or evaporation systems. Coastal water may carry considerable organic material, turbidity, oil, or other waste, so settle sea water before processing. Obtain the natural filtration and diluting benefits of ground water by processing water from shallow wells located along the shore. Since brackish or fresh water produces potable water more efficiently, use these sources as soon as the military situation permits. Hot, arid climates contain few, if any, fresh water sources large enough to support major military operations.

H. **Bottled Water.** Coast Guard units in the United States or overseas may use bottled water as a source of drinking water. Though bottlers commonly contend bottled water may be of better quality than locally available public water supplies, bottlers derive their water from surface or ground sources, and researchers have shown its quality can vary. Bottled water is only as good as the source from which obtained and quality of treatment received. Bottled water used at Coast Guard units must meet all applicable state regulations and all NPDWR requirements for physical, chemical, bacteriological, and radiological quality. In addition, bottling facilities must conform to FDA standards (21 CFR parts 110, 129 and 165) and be a member of the International Bottled Water Association.

Appendix 2.B. Model Potable Water Monitoring Program for the Medical Department Representative

1. Coordinate with applicable federal, state, and local regulatory agencies—including the area MLC—for information and guidance on the monitoring program.

2. Write a Standard Operating Procedure detailing the potable water monitoring program your branch or activity will follow.

3. Maintain full records and files, including these documents:

   a. An updated list of all water sources including type, location, quantity, quality, and treatment provided for each.

   b. A current set of plans of the water distribution system.

   c. Surveys, analyses, actions, and other information pertinent to the potable water system's sanitary surveillance.

   d. All regulatory agency and Coast Guard water regulations, instructions, and orders.

4. Collect samples for bacteriological analysis as directed, e.g., after disinfecting the system or mains, consumer complaints, special samples for studies after positive EPA or state samples, and monthly spot checks from points representative of major distribution system elements.

5. Do chlorine residual tests to investigate water problems, e.g., taste or odor, consumer complaints, and with each above bacteriological analysis.

6. Review the results of all EPA or state potable water analyses done at certified water laboratories and local analyses performed in Steps 4 and 5 above.

7. Inspect the water source, treatment plant if located on the installation, and storage and distribution systems at least quarterly.

8. Approve or ensure all chemicals and concentrations added to potable water supplies meet ☛ National Sanitation Foundation (NSF) Standard No. 60. Also, make sure water tank coatings, water hoses, and other materials used in or in contact with potable water meet applicable NSF Standards.

9. Where applicable, inspect the water treatment plant laboratory and review analytical procedures to assure compliance with Standard Methods.

10. Establish a program to locate and eliminate cross-connections.

11. Coordinate with the Engineering Officer (EO) to:

a. Discuss inspection results and analyses.

b. Make sure to inform medical department (preventive medicine) personnel of distribution system breakage, modification, flushing, shutdown, or disinfecting components or mains.

c. Ensure all portions of the distribution system under constant circulation maintain adequate chlorine residuals.

d. Develop contingency plans for natural or man-made disasters.

12. Pursue an aggressive continuing education program in health-related potable water training.

13. Guide the command on drinking water found in applicable federal and state drinking water regulations and this publication.

14. Report all known or suspected cases of waterborne disease following the procedures outlined in the ☛ Medical Manual, COMDTINST M6000.1 (series), Chapter 7, "Preventive Medicine."

Appendix 2.C. NPDWR Surveillance Requirements

System	Source	Test	Sampling Interval
COMMUNITY WATER	Surface Water	Inorganics	Annually
		Organics	Every 3 years
		Radiochemicals	Every 4 years
		Turbidity	Daily
		Coliform bacteria	Monthly[1]
		Trihalomethanes	Quarterly[2]
	Ground Water	Inorganics	Every 3 years
		Organics	State option
		Radiochemicals	Every 4 years
		Turbidity	State option
		Coliform bacteria	Monthly[1]
		Trihalomethanes	Quarterly[2]
NON-COMMUNITY WATER	Surface Water	Inorganics	State option
		Organics	State option
		Radiochemicals	State option
		Turbidity	Daily
		Coliform bacteria	Quarterly
	Ground Water	Inorganics	State option
		Organics	State option
		Radiochemicals	State option
		Turbidity	State option
		Coliform bacteria	Quarterly

1. Number of samples depends on number of people the system serves. See the State's drinking water regulations or the NPDWR.
2. For systems serving more than 10,000 people. For systems serving fewer than 10,000 people, monitoring is at State's discretion.
3. Consult the NPDWR amendments, published in the *Federal Register* (45 FR 57332, on 27 August 1980), on:
   a. Nitrate monitoring for non-community water systems;
   b. Sodium monitoring for community water systems;
   c. Corrosivity parameter monitoring for community water systems; and
   d. Microbiological indicators for community and non-community water systems.

Appendix 2.D. Contingency Planning for Potable Water

A. Introduction.

1. Purpose. This information will help Medical and Engineering Departments supply potable water ashore during emergencies and contingencies. It is adapted from the U.S. Department of the Army's "Installation Emergency/Contingency Planning for Potable Water Supplies."

2. Discussion. Emergency and contingency planning is one of the most overlooked aspects of supplying shoreside potable water. Very few facilities' documented contingency plan may prove valuable should an emergency arise. More often, the document actually is "a plan to make a plan" or a list of whom to contact in extraordinary circumstances. Though perhaps helpful, this is not a plan. A contingency plan is simply a document identifying what personnel are to do with existing resources at a particular pre- and post-event time and usually involves three elements:

    a. Anticipatory activities (vulnerability analyses);

    b. Identifying and managing information and resources; and

    c. Formulating remedial measures to "harden", i.e., "prepare" the water system.

3. Scope. To prepare a plan of this magnitude, planners must further define possible disasters and water uses. Disasters generally are associated with widespread nuclear war, the onset of natural geologic and weather patterns, or civil disorder and vandalism. Of paramount concern is the degree of physical damage to water, power, communications, and transportation networks. Under the stressful conditions any of these emergencies would produce, it also is important to thoroughly define intended water uses and dispersion points. While planners must apportion water first to sustain life, they also must determine amounts necessary for fire suppression, sanitation, decontamination, and industrial and commercial processes.

B. Preparing for Nuclear Attack.

1. Civil Defense. Drafted in the mid-1960s, much emergency and contingency planning guidance dealt primarily with surviving a nuclear attack. Official publications prescribed measures to protect against the initial blast and concomitant fallout and equip shelters with food, water, and ancillary equipment, e.g., medical kits and radiation detectors. Research shows shelters must store at least 2 quarts of water and 2,000 calories per person per day for healthy adult males. For planning purposes, provisioning is based on maximum shelter occupancy for two weeks or a total of 7 gallons of potable water and 28,000 calories of proper foodstuffs, e.g., no highly salted or sweetened items, for each occupant; these requirements may vary depending on the occupants' age, sex, and health. All stored water is to be used solely for drinking and cooking, not hygiene.

2. Outdated Supplies. Some planning information, particularly about storing shelter provisions, is outdated and invalid. For example, civil defense authorities provided water containers using twin 4-mil polyethylene bags sealed inside a 17.5-gallon steel drum. However, history proved these inner bags created a condensate that over time oxidized and corroded the outer drum, in turn degrading the plastic bags' integrity and eventually contaminating the stored water. Additionally, shelter personnel were to disinfect the water using iodine tablets stored in provided medical kits. Over the years, these kits were removed and/or the tables lost their potency. Manufacturers' instructions specify the iodine tablets should be tested every 2 years to determine whether they liberate a sufficient amount of iodine to properly disinfect the tablets.

C. Natural and Civil Threats.

Natural disasters, civil disorder, and vandalism pose a somewhat more imminent danger to an installation's vital utilities. The degree of damage a particular event produces depends on its relative magnitude and proximity to the utility and often is difficult to predict.

1. "Anticipated" Events. Hurricanes and floods possibly can contaminate any exposed water supply and inundate treatment processes and booster stations; accompanying regional power outages and disrupted transportation and communications networks can further exacerbate these situations. Such conditions would severely impair access to key points in the system to isolate specified areas and efforts to supply trucked or bottled water. The National Weather Service can warn of these events; planners can implement an effective management plan to minimize water system damage. To the greatest extent possible planners must prepare for these events beforehand.

2. Spontaneous Disasters. Earthquakes and tornadoes are somewhat more spontaneous, with increased damage to water treatment plant components, water intake systems, well casings, storage facilities, and distribution mains characteristic of common damage. Extensive, costly repairs may be necessary before affected water supply and distribution systems can provide consumers a reliable, safe product—leaving the community without such a source in the meantime.

3. Civil Threats. Recent events have demonstrated large utility systems' susceptibility to vandalism or civil disorder. For example, several southeastern U.S. communities have received threats to contaminate the water system by injecting toxic chemicals into it; these utilities were forced to cease operations and consumption until they could determine the existence or extent of the problem. Fortunately the only loss in these instances involved time and money. Such isolated events are not the only activities of concern, however. Large-scale water wastage produced simply by opening numerous hydrants, interrupting communications lines, curtailing maintenance and/or repairs, destroying watersheds, and threatening physical harm to operations and maintenance personnel may interrupt potable water service.

D. Developing Contingency Plans.

Responsible installation authorities must be aware of their system's strengths and weaknesses and undertake appropriate actions and rectify potential problem areas. Emergency planning at this stage is a two-phased operation: determining vulnerable aspects of the water system and then instituting remedial measures and delineating responsibilities.

1. Vulnerability Analysis. Assessing a water supply system's vulnerability involves determining or estimating the degree to which stressful or emergency situations would adversely affect it in relation to its responsibility. The basic idea is to identify key or vulnerable system components so planners can upgrade them as necessary to prepare for their absence after a disaster. Water system vulnerability involves more than intrinsic structural considerations; "hardening" a system also depends on the number of qualified personnel available, adequacy of stockpiled supplies and materials for emergency repairs and operations, availability of emergency power, and sufficient communications capability. This basic six-step program obtained from the American Waterworks Association Manual M19 provides a logical framework in analyzing vulnerability.

    a. Identify and describe the total water supply system's separate components using the headings of source, collection works, transmission system, treatment facilities, distribution system, personnel, power, materials and supplies, communications, and current emergency plans.

    b. Identify each possible disaster, even rare ones or combinations of calamities. This may involve a general review based on local and regional historical records and judgement and will suggest the type, severity, and magnitude of disasters to consider, e.g., earthquakes prevalent in the west, tornadoes in the midwest, hurricanes in the east, blizzards in the north, inundations or flash floods nationwide.

    c. Estimate each type of disaster's effects on each system component, most conveniently in tabular form.

    d. Estimate the both the quantity and quality of water demand during and after each type of identified disaster

    e. Critically review and analyze information developed in Paragraph D.1.c. to determine the water system's functional operation or capability to meet requirements estimated in Paragraph D.1.d.—how much water actually should be available in stressful circumstances versus demand.

    f. If the system fails to meet stated requirements, identify the key or critical system components primarily responsible for the failure. Focus on those interrelated with other components whose failure would render the entire system inoperative—these are the most vulnerable components. It may be helpful to assume everything is completely functional and evaluate the impact of any one component's failure, then attempt to determine if the system still could furnish an adequate water supply. Evaluate all processes and components in this manner. Next, determine which disaster or emergency would affect these critical items. An iterative process, planners may need to repeat Steps b. through f. several times to simulate varying conditions.

Applying the worst-case scenario or combinations of disasters to this process helps ensure the analysis will address most or all concerns.

2. Documenting Requirements and Responsibilities.

   a. Aspects of Contingency Planning. Using vulnerability analysis results, planners should be able to assess more accurately their particular facilities' capabilities and make necessary changes. Contingency planning should encompass actions that will minimize adverse impacts on the system if an emergency occurs and actions to take after such an event before resuming normal utility operations and service. A contingency plan addresses the activities associated with "hardening" a subject system and is comprised of four basic areas:

      (1) A documented inventory of vital information and available resources,

      (2) Prescribed remedial actions,

      (3) Defining personnel responsibilities and instructions, and

      (4) Identifying required employee training.

   b. Initial Planning Considerations. The initial planning phase—critical if the utility is to survive in stressful conditions—should encompass these activities, among others:

      (1) Inventory stockpiled and available equipment and materials.

      (2) Identify alternate water supplies and points of contact.

      (3) Compile critical maintenance records and current distribution maps, a particularly important step because it specifies the location, condition, and operation of system valves and gates, so emergency workers can swiftly isolate and if needed circumscribe key areas in an emergency.

      (4) Inventory special facilities and industrial activities. Identify which activities would continue to receive full water supplies under emergency conditions and what amounts would be given to ancillary activities; hospitals, clinics, shelters as applicable, and scientific and industrial functions necessary for local or national security would receive first priority.

      (5) List conservation techniques to implement if the water supply is diminished for a period after the emergency. Adopted conservation measures must be monitored and enforceable to be effective.

      (6) Coordinate between installation emergency services and those of the neighboring community(ies). Planners should initiate or participate in a forum or *ad hoc* committee to discuss what actions the installation may take jointly with neighbors to provide aid and resources or evacuation in an emergency. Among those involved in this effort are medical groups and institutions, police and fire

departments, and civil defense groups. Appropriate remedial actions would depend on the particular vulnerable areas identified in the preceding phase and the extent of protection warranted. Give first priority to upgrading the system's weakest or most vulnerable links. Overall, such protective measures may fall into one or more of several fundamental categories, discussed more fully below:

(a) Adequate structural design of shelter facilities, reservoirs, treatment processes, and storage tanks;

(b) Sufficient provisioning of such facilities;

(c) Automatic valving or easy access to manual values to close and isolate portions of the system;

(d) Developing multiple alternative water sources; and

(e) The security of facilities and personnel.

c. Structural Considerations. Water supply and shelter facilities that meet prescribed architectural and engineering specifications should adequately protect designated resources and prove durable over time. Certain prevailing circumstances, however, may make it advisable to "overdesign" or adhere to special design specifications and reinforce certain structures. Appropriate instances include utilities located on or near major fault zones or where they may be particularly susceptible to hurricanes or floods. In this latter case, it may be prudent to construct high berms or levees around low-lying areas.

d. Emergency Supplies and Instructions. After the initial step of defining necessary stockpiled or readily available materials and equipment, this step follows closely. For instance, a treatment facility should have 30 days' worth of necessary chemicals on hand in case communication or transportation lines are cut for a period of time. To carry this one step further, easy instructions for using these materials also should be handy. A case in point involves civil defense shelters, which must properly disinfect drinking and cooking water, particularly since the emergency water source may be less than ideal. Explicit instructions should explain for those who have never done so before how to prepare a standard disinfectant solution, desired concentrations for the water to be consumed, and the duration of contact time before consumption. A means to measure residual concentrations must be supplied as well. As with all stockpiled equipment, emergency planners must inspect and maintain such items at least once every six (6) months to ensure they will be useful when needed.

e. Criteria for Temporary Water Supplies. Important under normal circumstances, the ability to isolate portions of the distribution system becomes crucial in an emergency. It often is necessary in these instances to ensure either potable water reaches a certain end point uncompromised or keep potentially contaminated water from entering a specified portion of the system. Because communication and transportation lines usually are impaired during and after an emergency, a temporary, accessible supply must be found. Emergency workers can find such a supply trapped in each building's distribution piping and possibly supplement it with water in the community system that can be gravity-fed into the desired system. Contingency planners should inventory key buildings, e.g., hospitals and centrally located buildings that can house large numbers of people temporarily, to determine the amounts of water available through this alternative. This would be an effective tool for supplying civil defense shelters as well, with supplemental water stored on-site in approved, periodically inspected containers. Obviously the key to this source is documenting valve records and maps showing these appurtenances' accessibility and condition. Potential water sources within a particular building or distribution system segment include potable water storage tanks impervious to physical damage from an emergency, fire control tanks, sprinkler systems, hot water heaters, water closet flush tanks, air conditioning or chilled water systems, heating tanks and systems, indoor swimming pools, and reflector pools. Some of these alternatives are less desirable than others, so alternate water sources must meet these criteria:

(1) They must meet bacteriological and chemical criteria and standards, i.e., be sufficiently disinfected;

(2) They are isolated within the building or system before outside contamination and do not receive interior back-siphonage;

(3) They must be free of chemicals used to inhibit corrosion or lower the freezing point;

(4) Suitable dispensing devices must be present;

(5) Distribution is independent of outside power sources and electricity; and

(6) They are available all seasons, i.e., not emptied or frozen.

(7) Determine the potability of each alternative source separately.

f. Alternate Water Sources. Depending on a single potable water source, even under the best conditions, is risky. A contaminated surface- or ground-water source without a viable alternative could leave the installation in a tentative state. Ideally, tapping a number of available sources on-site, e.g., reservoirs, rivers, and aquifers, could provide alternate water sources. These sources rarely are evident, however. Among alternative sources planners should consider are an interconnection with a nearby municipal or district supply, redundant piping from the source or treatment works to the distribution network, and identifying readily available commercial sources, which would require coordination with those who transport purchased supplies.

g. Security Precautions. Resource security is vital at all times but particularly so during emergencies. Watershed areas, raw water sources, operational and maintenance personnel, emergency coordination centers and personnel, and accessible components of the treatment, storage, and distribution systems, e.g., pumping stations and hydrants, must be adequately secured and protected to ensure consistently high-quality potable water. Plans should discuss ways to thwart attempts to contaminate or debilitate the system and steps to take if such an instance is reported. In the latter instance, the Engineering Department should locate and analyze potentially affected consumers as soon as possible and notify MLC (kse); security personnel should discover method(s) of access to the system and promptly institute corrective measures; and the Engineering

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CHAPTER 3. TESTING WATER

A. Introduction.

Obtaining consistently reliable, valid test results is crucial in determining whether shipboard or shoreside water is palatable and potable or carries possible taste and odor problems or disease-causing organisms, thereby impairing morale and health. This Chapter describes the universal procedures to use in collecting water samples and performing either of the Coast Guard's two approved tests. The techniques described here are adopted from ☛ *Standard Methods for the Examination of Water and Wastewater*, current edition, published jointly by the American Public Health Association (APHA), American Water Works Association (AWWA), and Water Pollution Control Federation (WPCF).

B. How to Collect Bacteriological Water Samples.

In collecting all bacteriological samples follow these procedures to prevent accidental contamination:

1. Containers. For bacteriological analysis use only containers prepared for coliform sampling, properly sterilized, with a screw cap or an EPA-approved water sampling bag containing sodium thiosulfate for microbiological sampling to neutralize any remaining chlorine or bromine. Containers are sterile; do not open or rinse them before use because the sodium thiosulfate will wash out. Commercially prepared, Environmental Protection Agency-approved, sterile plastic water collection bags containing sodium thiosulfate are available from standard stock and are acceptable substitutes for glass bottles. Follow all instructions for sample container handling and storage.

2. Sodium Thiosulfate. Be sure the sampling container holds sodium thiosulfate before collecting the sample; many manufacturers add powdered sodium thiosulfate to their collection containers. If not, to prepare a 10% sodium thiosulfate solution, dissolve 10 gm sodium thiosulfate in 100 ml distilled water. Put 2 to 3 drops in 4-oz. capacity bottles and 4 to 6 drops in 8-oz. bottles. Loosely cap or stopper the bottles and autoclave at 121° C for 15 minutes at 15 psi. Cool to approximately room temperature. Then tighten the caps or stoppers. Or, ☛ see *Standard Methods for the Examination of Water and Wastewater,* current edition.

3. Sample Size: For most purposes, a 100 to 120 ml sample will suffice, but check beforehand with the testing facility to be sure.

4. Faucets. Take samples at the faucet.

   a. Avoid these types of faucets:

      (1) Faucets with aerators, swivel spouts, or add-on devices; remove them first;

      (2) Taps served by water treatment units such as water softeners; and

(3) Leaking faucets that permit water to run over the outside of the faucet.

b. If sampling taps are clean, free of attachments, and in good repair and if the water is allowed to flow at a uniform rate before sampling, flaming water taps before collecting potable water samples is not necessary. Do not alter the valve setting to change the flow rate during collection because doing so could affect the sample quality. Superficially passing a match flame or an alcohol-soaked cotton applicator over the tap a few times may have a psychological affect on observers, but will not kill attached bacteria; applying intense heat may damage the valve-washer seating or create a fire hazard if combustible materials are next to the tap. If successive samples from the same tap continue to show coliforms, disinfect the tap with a hypochlorite solution to reduce external contamination as the source of these organisms.

5. <u>Procedure</u>.

a. Always allow the water to flow moderately from a faucet for at least 3 minutes before taking the sample. Before collecting the sample, reduce the water flow to prevent splashing. Grasp the outside of the cap or stopper and carefully remove it.

b. Hold the sample container at the base, keeping hands away from the container neck. Be sure the inside of the container cap is protected and does not touch anything. Hold the cap in the hand.

c. Without adjusting the flow, fill the sample container to within ½-inch of the neck; leave about 20 percent air space at the top. Replace the cap immediately. If the sample is taken incorrectly, use another new sample container; do not reuse the original container.

d. Take a second sample using the same technique as the first, measure the pH and chlorine/bromine residual and record relevant information, e.g., date, time, disinfectant used, concentration, location, sampler's name, etc. For afloat units, record this information by filling out the Potable Water Quality Log. See ☛ Appendix 1.A.

6. <u>Handling</u>.

a. Package the bacteriological sample for delivery. On a form and on the sample container label record all pertinent field information. If sending individual potable water samples to the laboratory by courier, the maximum allowable elapsed time between collection and examination shall not exceed 6 hours, except for samples mailed from distant installations; hold these samples for a maximum lapsed time of 30 hours.

b. Samples must remain cool—at 4° C—during transit. Ship in insulated boxes, if needed, or refrigerate during transit. Allow 30 hours at most between sampling and test times when shipping from a distant location. Ensure the samples can be processed immediately. Record all samples' storage time and temperature; when interpreting data the examiner must consider these factors.

C. Accepted U.S. Coast Guard Bacteriological Testing Protocol: Colilert Test Technique.

1. Colilert Test Prodedure.

   a. Adhere to good laboratory practice throughout the test procedure. Avoid touching the reagent or the inside of the reaction vessels or caps.

   b. Carefully separate one Colilert Snap Pack from the strip; take care not to accidentally open the next pack. Tap the Pack so all the Colilert powder falls to the bottom.

   c. Aseptically open one Pack by snapping back the top at the indicated score line. The top remains attached to the rest of the Pack. Caution: Do not touch the Pack opening.

   d. Add the contents to a water sample of correct volume in a sterile, transparent, non-fluorescent borosilicate glass container or equivalent. Use a 100 ml sample with Catalog Nos. WP0200 and WP200 and a 50 ml sample with Catalog Nos. W050 and W050B. Aseptically cap and seal the vessel.

   e. Shake vigorously by repeated inversion to help the reagent dissolve. Some particles may not dissolve but dissolution continues during incubation.

   f. Incubate the reagent-sample mixture at 35° C ± 0.5° C for 24 hours.

   g. Read the reaction at 24 hours. Color should be uniform throughout vessel. If not, mix by inversion before reading. If yellow color is present, check for fluorescence; see Steps b. and c. below.

2. Test Results and Interpretation.

   a. At 24 hours, dispense the color comparator into an identical vessel and compare each reaction vessel to it. If the test vessel contains no yellow, the test is negative for total coliforms and *E.coli*. A yellow color equal to or greater the comparator confirms the presence of coliforms. The comparator shows the palest yellow and least fluorescence to indicate a positive test, which is typically much more intense than the comparator.

   b. If after 24 hours a sample is yellow, observe for fluorescence in a dark environment. Using only the UV lamp from the kit, check each yellow vessel by placing the UV lamp three to five inches in front of the sample; make sure the lamp faces away from the eyes and toward the vessel. Fluorescence equal to or greater than the comparator's fluorescence specifically confirms the presence of *E. coli* in that vessel(s).

   c. If a after 24 hours a sample is slightly less yellow than the positive comparator or indeterminate, incubate up to 4 more hours (a maximum of 28 hours total). In a coliform-positive sample, the color will intensify. If it does not, consider the sample negative. If the sample color remains indeterminate, consider the sample invalid and request another sample from the same site. Some water samples containing humic material may have an innate color. If a water sample has background color, compare the inoculated Colilert vessel to a control blank of the same water sample.

d. If an inoculated Colilert vessel is inadvertently incubated more than 28 hours, these guidelines apply: no yellow color is a valid negative test. Verify or repeat a yellow color after this incubation period.

D. Accepted U.S. Coast Guard Bacteriological Testing Protocol: Membrane Filter (MF) Technique.

1. Test Materials and Preparation.

a. Many ships are equipped with a membrane filter bacteriological testing kit. Kits and replacement parts are available from the standard stock catalog.

b. ☛ *Standard Methods for the Examination of Water and Wastewater* specifies two separate stock solutions are required to prepare a working solution of the phosphate buffer rinse. For convenience, these stock solutions are Solution A and Solution B.

(1) To prepare manually, make one (1) liter of Solution A—also called Phosphate Buffer Solution, available commercially—by dissolving 34 grams of potassium dihydrogen phosphate, KH_2PO_4, in 500 ml of distilled water. Then, to 500 ml distilled water, add 20 grams of sodium hydroxide, NaOH and add this solution to the first one to adjust its pH to 7.2.

(2) Prepare Solution B by dissolving 38 grams of magnesium chloride, $MgCl_2$, in one liter of distilled water.

(3) Prepare the working rinse solution by adding 1.25 ml of Solution A and 5 ml of Solution B to one liter of distilled water. Autoclave this solution at 121° C for 10 minutes at 15 psi before use. Most MDRs will want to arrange for a shore medical activity to make these solutions as most ships are not capable of adjusting Solution A's pH. Solutions A and B keep almost indefinitely if stored protected from contamination and out of direct sunlight.

c. In most cases, filters and absorbent pads are packaged together in a packet ready to be sterilized. Sterilize by autoclaving at 121° C for 15 minutes. Filters and pads also are available in pre-sterilized packages. Either type is satisfactory provided the filters and pads are sterile when used.

d. Sterile plastic petri dishes are available and recommended. If it is absolutely necessary to re-use these dishes, wash them, completely immerse opened dishes in

70% ethyl alcohol for at least 30 minutes, remove, place on a sterile towel, protect from dust, allow to air-dry, and reassemble.

e. Dipping forceps tips in alcohol and igniting the fluid adequately sterilizes them. Repeat this procedure after handling each filter. **Caution**: Allow forceps to cool a few seconds; membrane filters are extremely flammable.

f. Ready-to-use M-Endo broth in 2-ml vials, available through the Federal Stock Catalog, is recommended. Or prepare this medium by adding 1.2 grams of dehydrated M-Endo or MF Coliform powder to 24.5 ml distilled water containing 0.5 ml of 95% ethyl alcohol. *Do not substitute* any other alcohol for ethyl alcohol (ethanol), because other types often kill bacteria. Heat the solution to boiling, boil up to1 minute, remove from heat, and cool before using. Store this solution in a refrigerator up to 96 hours.

2. Conducting the Test. Follow this step-by-step procedure to perform the total coliform test with the membrane filter.

   a. Collecting and testing the water for a chlorine or bromine residual is not a part of the coliform test; however, the MDR normally measures and records a disinfectant residual after the water has run 2 or 3 minutes and before he or she collects it in a bacteriological test sample bottle or bag containing sodium thiosulfate.

   b. Clean the work area with potable water and allow the surface to dry.

   c. Prepare fresh medium for the day's testing. If using ampuled media (M-Endo broth in ready-to-use 2-ml vials), use one ampule for each sample filtration.

   d. Arrange and prepare certain equipment and supplies from the bacteriological water testing kit (Figure 3-A) for use as follows:

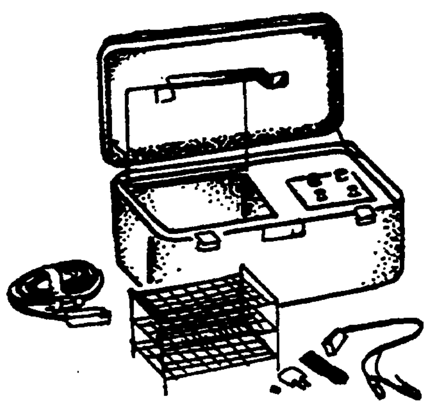


Figure 3-A Bacteriological water test kit

(1) Before each filtration series sterilize the field test kit by removing the stainless steel flask from the funnel base assembly to expose the absorbent ring around the holder base. Saturate the absorbent ring with approximately one-half capful of methanol; do not substitute any other alcohol. Set flame to the methanol on the absorbent ring, igniting the *entire* ring. Invert the filter cup over the funnel and burning absorbent ring for 15 minutes; the combustion produces formaldehyde, which sterilizes the filter cup; remove it; rinse the funnel thoroughly with sterile water; and the unit is ready for use. It is not necessary to sterilize this assembly between successive filtrations or between a series of samples unless 30 or more minutes elapse between them. To reduce the probability of contaminating each succeeding sample with bacteria present in the previous one, properly flush the funnel walls with sterile buffered water.

(2) Open the bottle of methanol; immerse the forceps in the methanol to about 1 inch.

(3) Before using the forceps, burn the alcohol off the tips in the Bunsen or alcohol burner. Hold the forceps in the flame only long enough to ignite the alcohol, as excessive heat will damage the forceps.

(4) Label the petri dishes to correspond to the sample number recorded on the analysis report.

e. Place one sterile absorbent pad in each petri dish, manipulating with the forceps.

f. Using a sterile pipette, deliver enough laboratory-prepared culture medium—approximately 2 ml—to saturate each absorbent pad or empty the contents of one ampule of medium on each absorbent pad (Figure 3-B). The proper amount of culture medium should allow a large drop to freely drain from the pad when the petri dish is tipped. Adequate medium is necessary for the organisms filtered out of the water to grow properly and provide valid results. On the other hand, using too much medium will cause the colonies to run together.

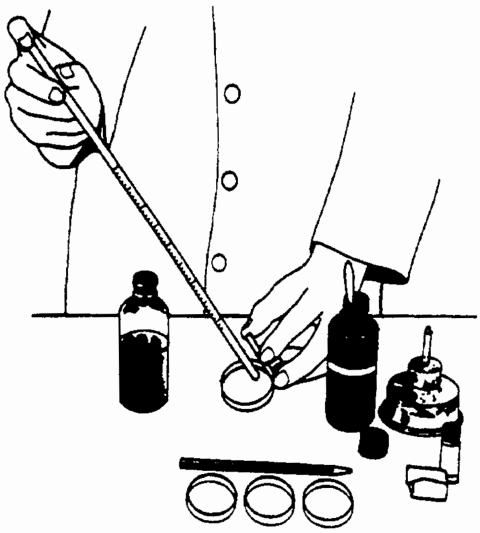


Figure 3-B Delivering culture medium to absorbent pad

g. Put a sterile membrane filter disk grid-side-up on the filter base and center it over the porous part of the membrane support plate (Figure 3-C). A membrane filter damages easily so always use a sterile forceps to grasp the *outer* part of the membrane filter to prevent damage to the porous part through which the sample is to be filtered.

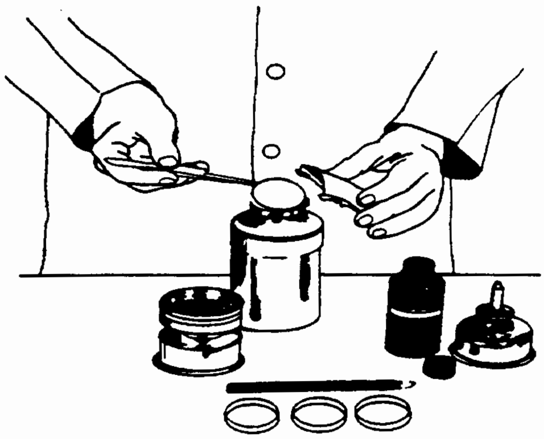


Figure 3-C Placing sterile membrane filter on filter holder

h. Attach the funnel element to the filter holder. To avoid damaging the membrane filter, never turn or twist the funnel element while seating and locking it to the filter holder. In securing the funnel element to a filter holder with a bayonet joint and locking ring, take special care to turn the locking ring sufficiently to fit snugly but not excessively tightly.

i. Filter the first water sample. Use a sterile graduated cylinder to measure sample and pour it into the funnel (Figure 3-D); then enter the volume of sample filtered in the appropriate space on the analysis report.

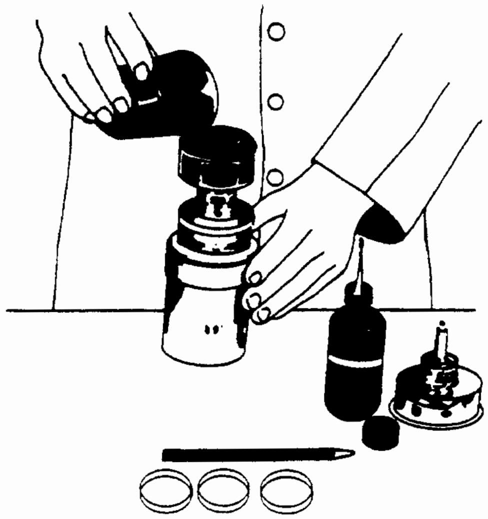


Figure 3-D Pouring the measured water sample into the funnel

j. Connect the hand suction pump to the filter base and pump to withdraw air; this helps the sample to pass through the filter (Figure 3-E).

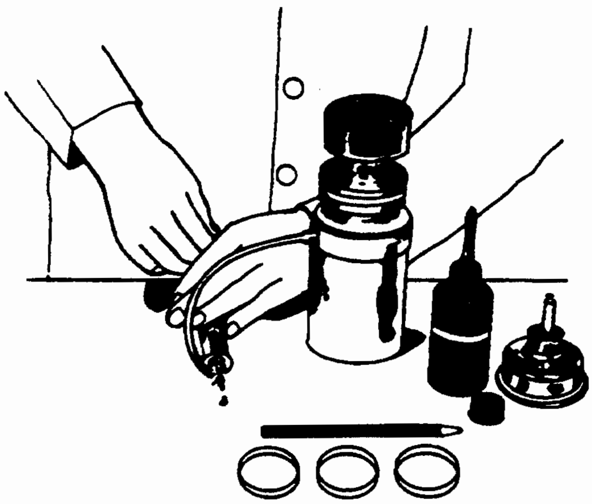


Figure 3-E Applying suction to the filter holder

k. After all sample has passed through the membrane filter, rinse funnel walls with at least 20 milliliters of sterile buffered water (Figure 3-F). If filtering several samples, rinse again after all the first rinse has passed through funnel to remove minute droplets from funnel walls and avoid contaminating subsequent samples. Stop pumping the filter assembly as soon as all the water of any sample has filtered because continued suction with no sample may introduce airborne contamination.

Figure 3-F Rinsing down funnel walls

l. Remove the funnel from the filter holder.

m. Use sterile forceps to remove the membrane filter from the filter holder (Figure 3-G) and carefully place it grid-side-up on the saturated pad, taking care not to trap air bubbles between the membrane and the pad (Figure 3-H); then close the petri dish. To avoid air bubbles, which hamper the culture medium from diffusing throughout the membrane filter, have enough culture medium on the absorbent pad and roll the membrane filter into position. If necessary, reseat the filter on the absorbent pad to eliminate bubbles.

Figure 3-G Removing the membrane filter from the filter holder

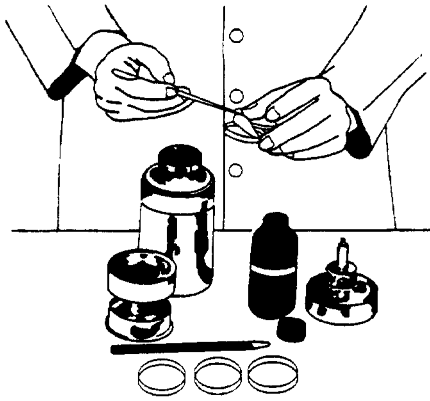


Figure 3-H Placing membrane filter on the absorbent pad saturated with culture medium

n. After placing all the membrane filters in petri dishes, put the dishes grid-side down in the incubator and incubate at 35 C ± 0.5 for 22 to 26 hours. Put a wet sponge in the incubator to maintain approximately 90 percent relative humidity during incubation.

o. After incubation, remove the cultures from the incubator (Figure 3-I).

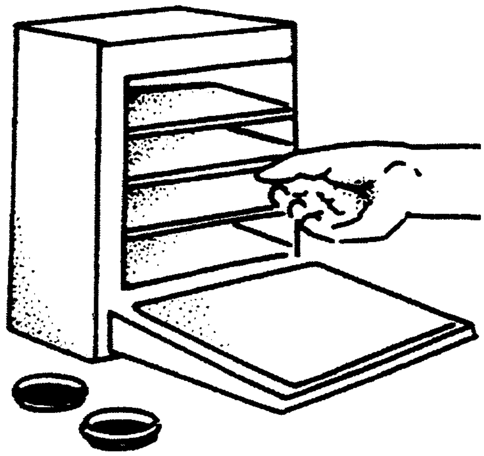


Figure 3-I Removing petri dishes from incubator

p. A greenish-gold metallic sheen indicates colonies (Figure 3-J). To interpret results, see ☛ Paragraph 3.D.4.

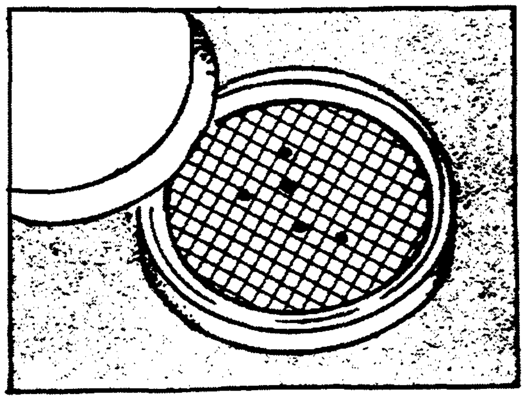


Figure 3-J Observing petri dishes for colonies

3. Optional Membrane Field Monitor Method. Follow this step-by-step procedure to perform the total coliform test with the microbiological analysis monitor.

   a. The membrane field monitor consists of a monitor, membrane filter, and absorbent pad encased in plastic with top and bottom holes fitted with plastic plugs, a syringe, a sterile sampling tube, and a long ampule of medium with one tip covered with a short plastic tube. Remove the plugs from the monitor; save them. Attach the syringe pump valve connection into the hole in the monitor's bottom (the side with spokes).

   b. Remove the sterile sampling tube end with the nylon valve tip from its plastic sleeve and attach the nylon tip into the inlet hole on the side of the monitor (Figure 3-K).

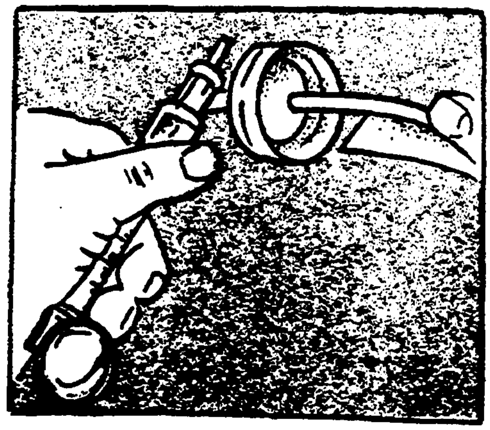


Figure 3-K Attaching nylon valve tip into monitor inlet hole

   c. From the other end of the sterile sampling tube remove the plastic sleeve and put the tube end into the water sample. Draw the syringe plunger slowly on the first stroke to avoid an air lock. Hold back on the plunger until the syringe fills. Push forward on the plunger to expel the filtered water from the syringe. Filter the sample, normally 100 ml, through the monitor. Invert the assembly and use short quick strokes to pull any remaining water from the sample.

d. Remove and discard the sampling tube; do not remove the monitor from the syringe (Figure 3-L).

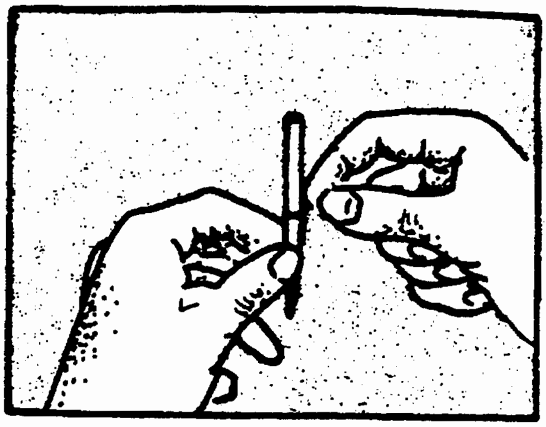


Figure 3-L Removing sampling tube

e. From an ampule of medium break off the tip covered with the short plastic tube. Place the forefinger over the end of the plastic tube as if it were a pipette. Break off and discard the other end of the ampule (Figure 3-M).

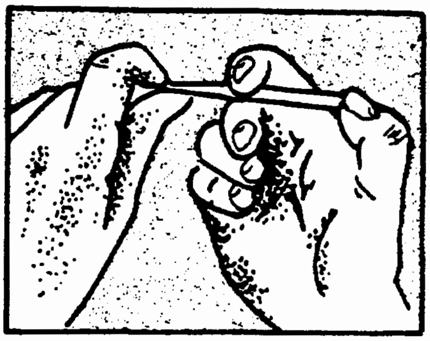
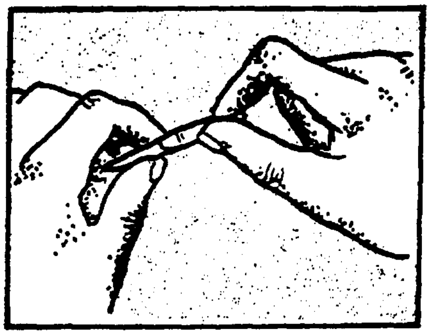
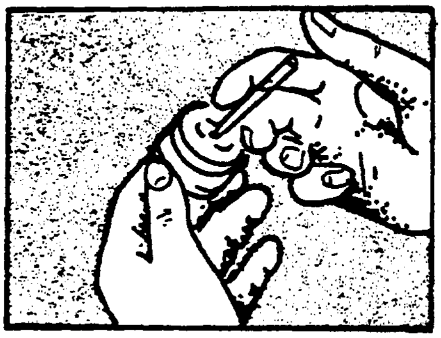


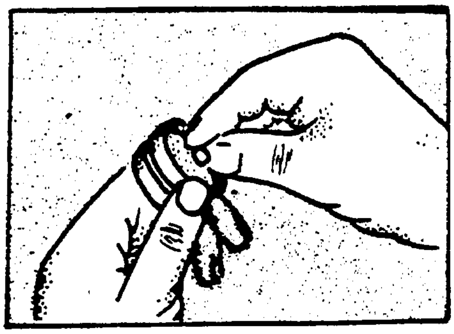
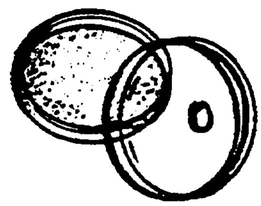
Figure 3-M Breaking off end of ampule

f. Remove the monitor from the syringe; insert the ampule's free end in the hole in the bottom of the monitor; press it gently against the absorbent pad. Release the forefinger and slowly release the pressure against the absorbent pad, allowing the medium to flow into the pad (Figures 3-N and 3-O).

Figures 3-N, 3-O Allowing media to flow into absorbent pad

g. Replace the plastic plugs, invert the monitor, place in an incubator at 35 C ± 0.5 for 24 hours. Pry off the top, observe for the presence or absence of coliform colonies, and record as previously described (Figures 3-P and 3-Q).

Figures 3-P, 3-Q Removing monitor top and observing for colonies

4. Interpreting Total Coliform Test Results. Colonies on the membrane filter appear as dark, various-sized dots with a metallic, usually greenish-gold, sheen that may appear only at the center, only on the edge, or over the entire colony. Pararosalinine, a dye in the medium, reacts with coliform-produced aldehydes to create the metallic sheen. Non-coliform colonies appear as clear, colorless, or dark colonies that may glisten but do not have a metallic sheen. Report non-coliforms as "background". Occasionally, coliforms do not produce a metallic sheen. Therefore, tests consistently producing high colony counts but no metallic sheen warrant further examination of these background colonies.

5. Controls. Perform fresh positive and negative controls for each group of samples processed.

   a. To obtain a negative control, substitute 100 ml sterile distilled water for a sample and process exactly the same as a sample. If the control is positive, the technique has an error and the methods should be examined.

b. To obtain a positive control, place a fecal-contaminated swab in 100 ml of phosphate buffer. Shake the solution well; filter a small portion of the suspension. If this method produces too many colonies, pipette 1 ml of the positive control buffer solution into 99 ml of sterile phosphate buffer to dilute the number of bacteria in the control, and filter 10 ml of this dilution. Record the results of positive controls in the water log as total coliforms present or absent. If the positive control test procedures produce only a few colonies, check whether laboratory practices, procedures, and supplies, e.g., phosphate buffer solution, culture medium, are satisfactory.

6. Reporting. For afloat units, enter bacteriological testing results in the Potable Water Quality Log and report to the unit Commanding Officer, with a copy to the Engineering Officer. See ☛ Appendix 1.A. For ashore units, report results as required by State/EPA regulations.

Appendix 3.A.

Remedial Actions for Contaminated Water Samples

Condition	Possible Cause	Recommendations
I. No known sanitary defects, health hazards, or incidents of gastrointestinal disease.	The contaminated samples might indicate a localized situation within the building piping where the sample was collected or a faulty sampling technique.	1. Collect repeat samples promptly. 2. Expedite sample shipment to obtain a prompt report from the laboratory. 3. Investigate immediately to determine whether any unusual conditions have occurred, e.g., water main, faucet, or piping repairs within the building or near the sampling point. 4. Test for chlorine at various outlets to ensure proper dosage. 5. If this investigation shows the need, flush the portion of the system by opening outlets until a proper chlorine residual is recorded; chlorinate locally if needed. 6. Resample. 7. If examination shows any conditions listed in Paragraph II below, follow the remedial actions recommended there.
II. Occurrence of a major disaster, e.g., inundation of the source, break-down in treatment plant units, a cross-connection grossly contami-nates the system, underwater crossing failure, earthquake damage, etc.	Self-evident	1. Immediately reject water supply system. Institute an emergency treatment program. Treat all drinking and cooking water. 2. Complete all necessary repairs. Super-chlorinate and flush the entire system. 3. Collect samples from representative points throughout the system until at least two consecutive sets of standard samples collected on different days yield negative microbiological results. 4. Remove restrictions on water use.
III. Occurrence of an outbreak of one of the so-called waterborne diseases.	Water system contaminated at the source, in reser-voirs, treatment facilities, or distribution system and not generally obvious at the onset of the outbreak.	1. Implement Condition I recommendations; especially emphasize investigating the source, reservoirs, treatment processes, and distribution system. 2. Increase the system's chlorine dosage and residual. 3. If the conditions causing the contamination are serious, e.g., direct sewage contamination, reject the supply and institute emergency treatment until the condition is corrected.

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CHAPTER 4: WASTEWATER TREATMENT AND DISPOSAL AFLOAT AND ASHORE.

A. Introduction and Policy.

1. Purpose. This Chapter describes methods to treat and/or dispose of wastewater at Coast Guard ashore and afloat facilities and prescribes procedures to prevent transmitting communicable diseases associated with human wastes in operating and maintaining these wastewater systems. This Chapter is not a technical guide for treatment plant operation.

2. National Effluent Guidelines. The Federal Water Pollution Control Act Amendments of 1972 (PL 92-500) established the National Pollutant Discharge Elimination System (NPDES), a program to control water pollution in the nation's waterways by limiting the discharge of polluted effluents from point sources into navigable waters. Each industrial, agricultural, and municipal wastewater discharger must obtain an Environmental Protection Agency (EPA) or state regulatory agency discharge permit limiting that activity's effluents based on the published national effluent limitation guidelines. Under this system, a discharger must monitor its own pollutant discharges and submit periodic reports to the control agency. If a discharger cannot comply immediately with established limitations, the permit includes a schedule of deadlines by when the activity must reduce its pollutants. Violating a NPDES permit carries a maximum fine of $27,500 and/or up to one year in prison for first time negligent offenses. Penalties for knowing or repeat offenses are higher. Title 40, Code of Federal Regulations, Parts 100 to 149 (40 CFR 100-149), contains information about the effluent guidelines. Obtain copies from the Government Printing Office, stock number 021-610-00094-1, at:

   Superintendent of Documents
   Post Office Box 371954
   Pittsburgh, PA 15250-7954
   Telephone: (202) 512-1800

To access all CFRs electronically: http://www.access.gpo.gov/nara/cfr/index.html

3. Policy.

   a. Legislative Authority. The Coast Guard is subject to all substantive and procedural requirements of the Clean Water Act and any state equivalent. 40 CFR 100-149 and Executive Order 12088 require Federal agencies to conform to Federal, state, interstate, and local pollution control regulations and take the lead in protecting and enhancing air, water, and land resources' quality. Installing, operating, and maintaining shipboard pollution control equipment and systems are mandatory. Ship crews must use existing pollution control equipment and procedures to prevent polluting the seas and coastal areas to effectively protect and enhance their water quality and prevent possible litigation against the U.S. Coast Guard.

b. Coast Guard Policy. The Coast Guard will actively protect and enhance environmental quality by strictly adhering to all applicable regulatory standards, planning and implementing programs to control pollution caused by Coast Guard facilities, and establishing methods to monitor the effectiveness and compliance of these actions.

c. Additional Legislation. Executive Order 12088 requires Coast Guard shore facilities and forces afloat to cooperate with Federal, state, and local environmental protection organizations and comply with their official substantive standards and criteria. The Clean Water Act of 1977, PL 95-217, requires Coast Guard facilities to comply with state or local administrative pollution abatement and control procedures. If national defense or other relevant reasons make it impractical to do so, the unit commanding officer must refer the matter through the chain of command to the Commandant, United States Coast Guard, for resolution. Coast Guard installations overseas must cooperate with foreign host nations and communities and to the extent practical take pollution abatement measures equal in degree and timing to the host nation's. Coast Guard ships in foreign harbors and overseas units must conform to environmental quality standards published in applicable international, bilateral, and Status of Forces Agreements the U.S. Government has signed.

4. Responsibilities. Coast Guard-wide responsibilities to prevent, control, and abate environmental pollution caused by Coast Guard ships and facilities are as follows:

a. Commandant. The Commandant, United States Coast Guard (G-SEC and G-SEN), promulgate Coast Guard policy and assigns responsibility to protect Coast Guard military and civilian members from health hazards associated with wastewater disposal systems; see ☛ Naval Ship's Technical Manual (NSTM), Chapter 593, "Pollution Control."

b. Maintenance and Logistics Commands. Area Maintenance and Logistics Commands (s) provide technical assistance on complying with permits to area coordinators and Coast Guard activities and also serve as the principal contact between Coast Guard commands and EPA Regional Offices in obtaining and completing permit applications. Area Maintenance and Logistics Commands (kse) evaluate wastewater disposal systems ashore and afloat to ensure they prevent potentially hazardous conditions that could adversely affect the health of Coast Guard military and civilian members.

c. Unit Commanding Officers. Unit commanding officers (COs) obtain discharge permits, if required, and ensure wastewater treatment facility operations and the quality of all applicable effluents discharged into navigable waters comply with federal and local standards.

B. Coast Guard Discharge Permit Requirements.

All Coast Guard activities discharging domestic or industrial wastes into navigable waters, the contiguous zone, and/or the oceans must have discharge permits. However, Coast Guard vessels are exempt from having discharge permits. Coast Guard shore facilities that discharge into publicly-owned treatment works or non-Coast Guard-owned sewage systems must have permits to pre-treat industrial wastes. Storm sewer outlets not receiving polluted effluents, injection wells, and agriculture projects are exempt from discharge permit requirements. For shore commands that require discharge permits, unit engineering officers shall complete permit applications and submit them to EPA or the state, as appropriate, by 180 days before the date the discharge is to begin. Most permits are valid for 5 years and require reapplication 180 days before the current permit expires.

C. Wastewater Treatment and Disposal Afloat.

1. Introduction. Discharging untreated sewage overboard within U.S. navigable waters and territorial seas (within 3 nautical miles of shore), and in designated sewage no-discharge zones is prohibited. Discharging graywater is not prohibited by Federal regulations, however, local regulations vary. Uniform national discharge standards have been proposed by DoD to clarify discharge requirements for military vessels and may be enacted in the near future. Coast Guard vessels are equipped with Marine Sanitation Devices (MSDs) that either treat sewage before discharge or collect and hold it until the ship can properly dispose of it through dockside sewer connections or pump it overboard in unrestricted waters. MSDs increase the possibility Coast Guard ships could contaminate berthing and working spaces with raw sewage. Therefore, the Medical Department Representative (MDR) must be familiar with the sewage disposal system and necessary procedures to ensure the ship's crew's health and safety.

2. Marine Sanitation Devices.

    a. Collection, Holding, and Transfer (CHT) System. Most Coast Guard vessels have CHT systems designed to operate in three locations: in *restricted* waters, sewage is collected and stored in holding tanks while diverter valves discharge gray water overboard; at *sea*, all sewage and gray water, including any stored in the holding tanks, is diverted or discharged overboard; and in *port*, sewage and gray water are collected in holding tanks and discharged into a sanitary sewer. The CHT system is composed of three functional elements:

        (1) The collection element consists of soil drains from toilets and urinals; gray water drains from showers, laundries, and galleys; and diverter valves that direct wastewater over the side or to holding tanks.

        (2) The holding element consists of tanks, normally large enough to hold 12 hours' worth of waste, depending on individual ship conditions, during transit in

restricted waters for eventual disposal. Larger, 2,000-or-more-gallon holding tanks (Figure 4-A) are equipped with comminutors to grind and liquify solids passing into the tanks and an aeration system to prevent sludge from settling and becoming anaerobic. Smaller tanks (Figure 4-B) incorporate strainers that prevent solids from entering tanks.

(3) The transfer element includes sewage pumps, overboard and deck connection discharge piping, and associated diverter and check valves. Each tank has two sewage discharge pumps connected in parallel to discharge sewage and gray water directly overboard or to a receiving facility, the Sewage Waste Off-loading Barge (SWOB). *Note*: Many smaller vessels have one sewage discharge pump.

b. The Engineering Department can operate the CHT system two ways: manually, when the pumps run independently of the wastewater level in the holding tanks with an option available that automatically stops the pumps when a tank's low liquid level reaches approximately 10% of the tank volume to maintain pump suction. In the second, fully automatic mode, the system accomplishes these functions:

(1) Duty pump alteration.

(2) To keep the pumps primed, the low liquid level stops the pump when the tank level reaches approximately 10% of its capacity.

(3) At 30% liquid level, a sensor signals the duty pump to activate.

(4) At 60% liquid level, a sensor signals the standby pump to activate.

(5) The 80% liquid level activates a visual and audible high-level alarm.

3. Inspecting Marine Sanitation Devices.

a. Labeling and Color-Coding.

(1) On the interior of the ship, MSD valve handles and operating levers, excluding gauge valve handwheels located on gaugeboards, must be color-coded gold (Gold Paint NSN 0810-00-938-7724). Exterior deck discharge stations must be painted the same color as the surrounding structure.

(2) Deck discharge stations must be clearly labeled to include hose-handling procedures and sanitary health precautions described in ☛ GENSPECS 593.

b. Appropriate engineering personnel responsible for the compartment holding the MSD components must regularly inspect them for leaks. These inspections should include these examinations:

(1) Soil and waste drains, discharge lines, flanges, joints, access plates, clean-out plugs.

(2) Gate and ball valves.

(3) Plug valves.

(4) Comminutors and motors.

(5) Automatic pump starters.

(6) Sewage pumps, including housings and seals.

(7) Tank penetrations and manholes.

(8) Air compressors.

(9) Drip pans.

(10)When operating in port, inspect sewage transfer hoses and riser connections.

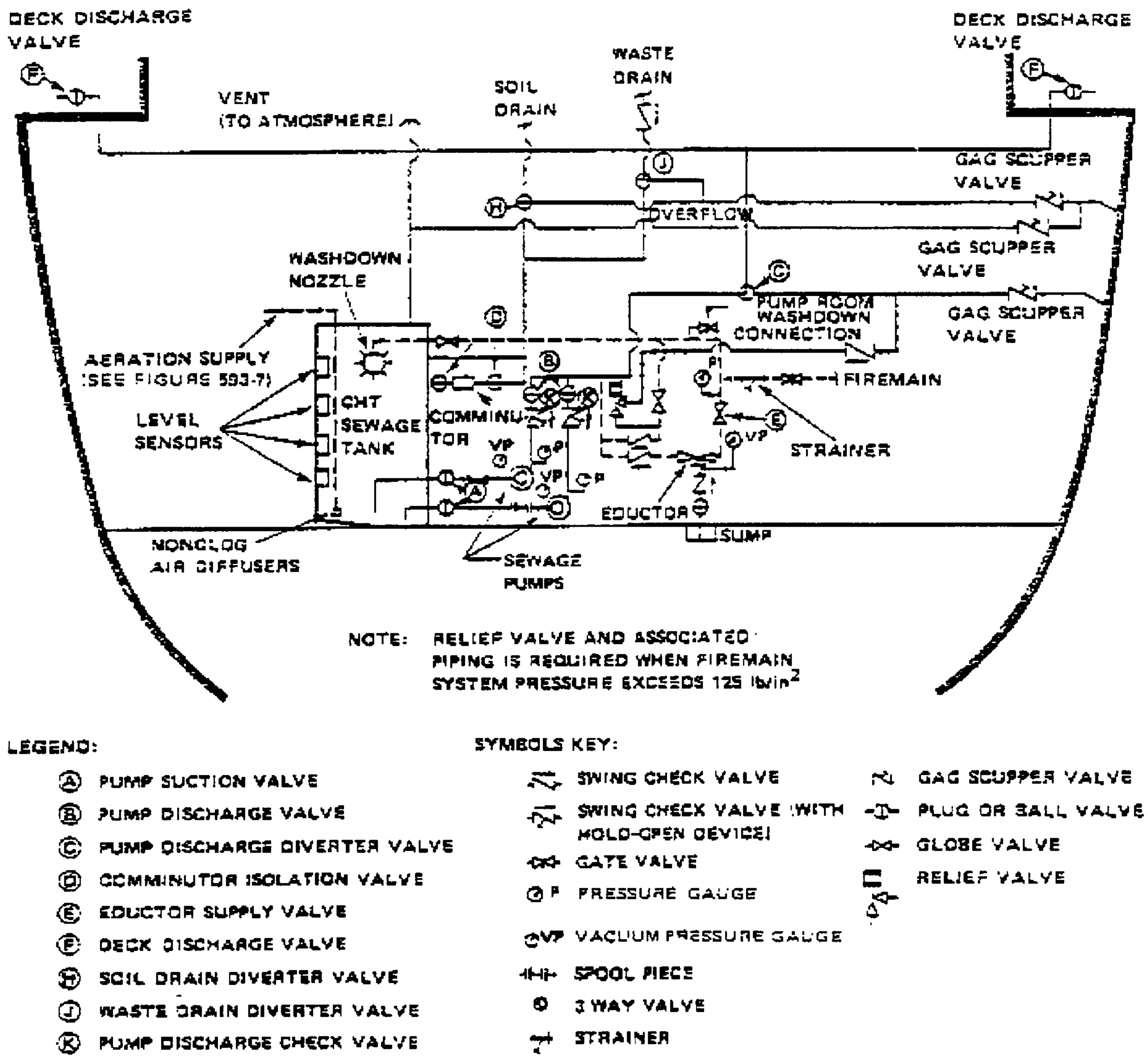

Figure 4-A: CHT System with Comminutor

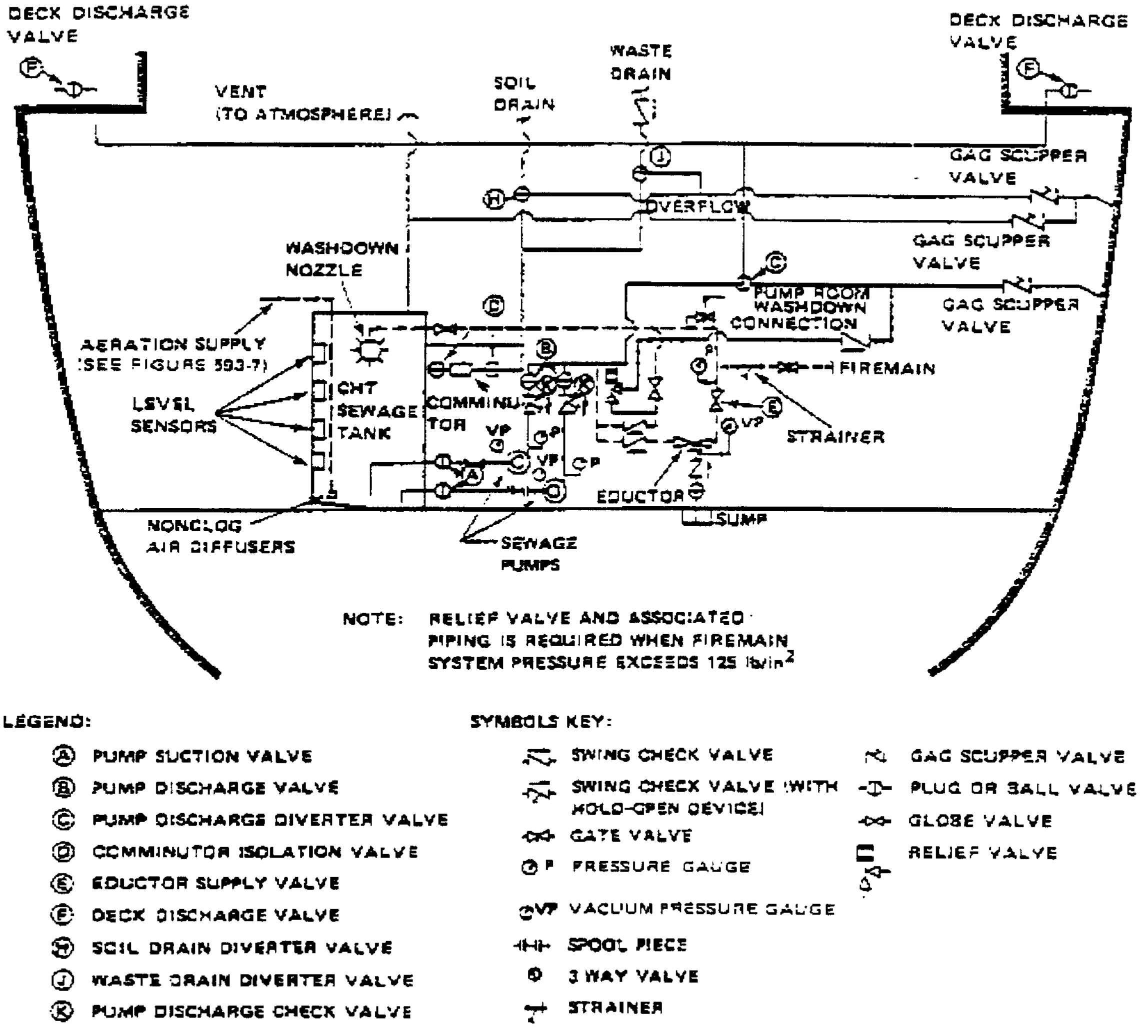

Figure 4-B: CHT System with Strainer

c. Pinpoint small leaks from pumps, comminutors, and piping system pressurized sections with the "paper towel" test: open a paper towel and hold it suspended 2 to 3 inches from the units for several minutes while they operate. Detect the source of even the finest spray by spots or wetness on the paper towel.

d. Inspect the ventilation system installed in the MSD room. Additionally, check any existing sump space for sewage accumulation.

e. Promptly report all leaks, spills, or other sources of contamination observed during these inspections or any other time to the Executive Officer, engineering or damage control officer, and the senior MDR. Take appropriate action to arrest the leak; properly clean and, when appropriate, disinfect the contaminated area as described in ☛ Paragraphs 4.F.5. and 6.

4. Ship to Shore Sewage Transfer.

   a. Sewage-receiving facilities have been constructed at most shore activities with fleet support capability. These facilities include sewer risers located along all piers and quay walls to transfer sewage from ship discharge risers to the shore sewer system and facilities to store, maintain, and repair sewage transfer hoses.

   b. Coast Guard MSDs are designed to discharge sewage directly to a shore receiving facility when in port by connecting the ship's sewage discharge risers to the pier sewer risers or indirectly by connecting to a SWOB or another ship's system that in turn discharges the sewage into pier risers.

   c. Connect ship-to-ship (Figure 4-C) when several ships are nested at one pier or berth or when a vessel is nested to a tender. Some ships with CHT systems have athwartship piping that allows them to receive wastewater from an adjacent ship and transfer it to another ship with the same capability. Thus, Engineering personnel can connect several ships' Type III-B CHT systems in series so they convey the sewage generated on these ships through to the pier risers. Vessels with I, II, or III-A systems do not have the pump-through capability and must be connected directly to a pier, SWOB, or a ship, e.g., a tender, with pump-through capability.

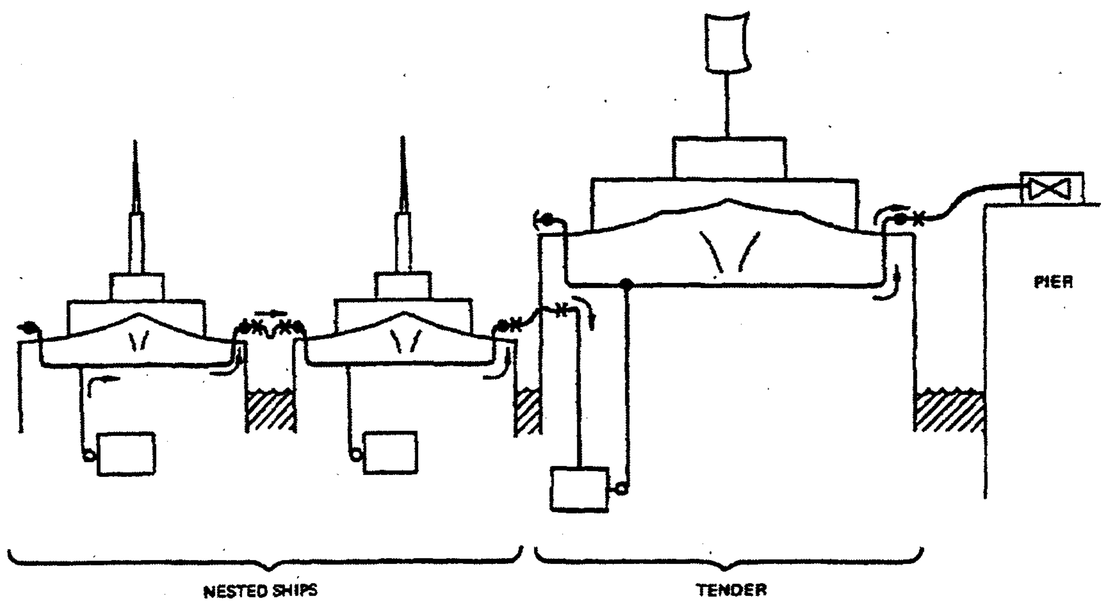

Figure 4-C: Nested Ship Sewage Transfer

   d. The receiving facility makes most sewage connections, including ship-to-shore and ship-to-ship, by 50-foot-long, 4-inch-wide flexible rubber or plastic sewage transfer hoses. When a ship arrives for berthing, shore-based handling crews may deliver to the pier the proper number of clean sewage transfer hoses and connects them to the pier risers. The ship's crew connects transfer hoses to the ship's risers on ship-to-shore and ship-to-ship connections.

e. Engineering personnel must clean and maintain sewage transfer hoses to avoid unsanitary conditions. Before returning the hoses to storage after use, before disconnecting the hoses the cleaning crew must clean them of residual wastewater, usually by flushing the hoses for at least 10 minutes with high-pressure salt water admitted to the MSD discharge piping from the ship's fire fighting system. If a vessel does not have this capability, the cleaning crew must flush the hoses by connecting them to the nearest saltwater pier riser. In addition, the cleaning crew must clean the hose couplings and exterior surfaces and cap the ends of the hoses before storing them. ***NEVER*** use sewage transfer hoses for potable water connections.

f. Report wastewater spills as required by Federal or local regulations. If wastewater spills onto the ship's deck or the pier, thoroughly flush the affected area into the harbor with high-pressure salt or fresh water. Use an approved disinfectant, e.g., NSN 6840-00-753-4797, disinfectant Germicidal Fungicidal concentrate (phenolic type), to prevent or eliminate strong odors caused by the spilled wastewater.

g. Sewage hose handling and storage facilities are designed to accommodate sewage transfer hoses' repair, maintenance, and storage. Hose-handling and -storage facilities must incorporate these design features to avoid conditions that could cause accidents or communicable diseases:

(1) Racks and tables used for sewage transfer hose-handling and -storage must be constructed of metal or other impervious material. Wooden racks and tables are prohibited.

(2) All windows and doors opening to the outside must be adequately screened to prevent flying insects from entering.

(3) Back-siphonage prevention devices must be installed on all potable water lines used to flush and clean sewage transfer hoses.

(4) The Engineering Department must provide adequate handwashing facilities, including soap, warm water, and paper towels, conveniently located inside pump rooms.

(5) The Engineering Department must provide lavatories and showers with hot and cold running water, soap, and single-use towels.

(6) The Engineering Department must provide sufficient ventilation in all indoor work spaces.

(7) Incandescent and fluorescent lights must be protected from breakage. And, if not provided, the Engineering Department must install non-slip surfaces on the deck in hose-washing areas.

(8) Disinfecting sewage transfer hoses is not normally required; however, the hose-handling facility should have this capability if the need arises.

(9) The sewage hose handling and storage facility must be constructed, equipped and operated to comply with applicable Occupational Safety and Health Administration (OSHA) health and safety regulations.

5. <u>Sewage Spill Clean-up Procedures</u>.

a. **Warning: Sewage spills may create toxic or explosive atmospheres. Always obtain approval from ship's gas free engineer before cleaning up sewage spills.**

b. Determine the extent of contamination through visual observation. In food service, medical, or berthing spaces, evaluate the possibility of contaminated food or produce, medical items, and bedding.

c. Secure the contaminated space to general traffic to limit tracking sewage to other spaces.

d. Determine if the spill or leak source has been identified and corrected.

e. Ensure cleaning and/or repair personnel wear protective clothing during clean-up operations.

f. To clean contaminated spaces use only a standard stock detergent and hot water. Contaminated food service, medical, and berthing spaces require additional treatment with an approved disinfectant.

g. Immediately after cleaning and disinfecting procedures, wash contaminated clothing with hot detergent water, rinse, and treat with an approved disinfectant.

h. Isolate food items, linen, bedding, or other contaminated materials. Bag contaminated linen and send it to the laundry; other items will require cleaning and disinfection. Survey food items that are not canned or completely sealed. Depending on the extent of contamination, cleaning and disinfecting the container exterior will salvage most canned food items.

i. The Medical Department Representative (MDR) will instruct all personnel involved in cleaning and repair operations to shower thoroughly before engaging in any other activities.

j. Pump out bilges contaminated with sewage, wash them down with a fire hose, and pump them out again. If potable water tanks make up the bilge's deck, the MDR will initiate and continue bacteriological monitoring until he or she can ascertain no contamination is present. If the MDR suspects the potable water is contaminated, he or she must arrange to have engineering personnel secure the appropriate tanks until he or she can determine the water is safe. ***Note: Do not pump bilges if located in sewage-restricted waters; relocate to an unrestricted area or report spill and obtain approval from Federal or local authorities.***

k. Ship's personnel must not use open flames, flashlights, or electrical apparatus in or near the open tank or other voids until the Engineering Officer certifies they are gas-free.

l. After the clean-up is completed, use these compounds to disinfect the affected area:

Solution	NSN Stock Number
Povidone-Iodine Solution, USP	6505-00-754-0374
Disinfectant, Germicidal and Fungicidal Concentrate (Iodine Type)	6840-00-526-1129
Disinfectant, Germicidal and Fungicidal Concentrate (Phenolic Type)	6840-00-753-4797

m. Dispose of all contaminated wastes as directed for disposing of infectious medical wastes; see ☛ the Safety and Environmental Health Manual, COMDTINST M5100.47 (series).

6. Personal Hygiene, Sanitation, and Safety.

a. Strict adherence to good personal hygiene and sanitary practices is essential to prevent the spread of fecal contamination and resulting potential for a communicable disease outbreak.

b. Personnel must wear protective clothing including coveralls, rubber boots, rubber gloves, face shields, hair covering, and an approved respirator as appropriate when they are likely to contact sewage during maintenance or spill clean-up operations. If the ship does not have an Authorized Equipment List (AEL), a recommended list that contains stock numbers for clean-up equipment is found at ☛ Appendix 4.A.

c. Personnel who contact sewage in the course of their duties or due to a sewage spill or system backflow must adhere to these requirements to minimize the spread of contamination to other areas of the ship.

(1) While wearing contaminated clothing move about the ship to an absolute minimum.

(2) Put contaminated clothing in a plastic bag when maintenance or spill clean-up operations conclude. Launder in hot water and detergent separately from regular laundry.

(3) Wash rubber boots, gloves, respirator, and other similar items with hot, soapy water, rinse with hot, clean water, and treat with an approved disinfectant solution.

(4) Personnel must thoroughly wash with soap and water before engaging in other activities.

e. Cleanup personnel must thoroughly wash down spaces contaminated by leaked, spilled, or backflowed sewage with warm water and a stock detergent. Further, treat food service spaces, berthing areas, and medical spaces with either approved Iodine- or Phenolic-based, EPA-registered and -labeled Germicidal and Fungicidal disinfectant cited in ☛ Paragraph 4.C.5.l. above. Follow label instructions when using these agents so they will be effective.

f. Pump out, wash down with a fire hose, and re-pump out bilges contaminated with sewage wastes. If potable water tanks form the floor of the bilge, promptly monitor the water from those tanks daily for bacteria and continue until monitoring establishes sewage has not contaminated the tanks. Furthermore, if the MDR suspects the potable water system is contaminated, the Engineering Department must secure the appropriate tanks until the MDR determines the water is safe. . ***Note: Do not pump bilges if located in sewage-restricted waters; relocate to an unrestricted area or report spill and obtain approval from Federal or local authorities.***

g. The Engineering Department must post signs in spaces containing MSD equipment warning maintenance personnel not to eat, drink, or smoke in MSD spaces and directing them to thoroughly wash with soap and water before leaving the area.

h. Personnel who handle or connect sewage transfer hoses must first wash and change into clean clothing before subsequently handling potable water hoses.

i. Put no open flames, flashlights, or other electrical apparatus in or near open holding tanks or other voids until a gas-free engineer has certified them safe as described in ☛ NSTM, Volume 3, Chapters 074 and 593. When the tank is gas-free and safe, personnel may enter using an OBA or other approved respiratory protection device specified in ☛ NSTM, Chapter 593. If only one person enters the tank, he or she must use a safety harness and tending line. If two or more persons enter the tank, they must keep in constant sight of each other. Personnel must always stand outside the tank to watch and assist those inside. Additional health and safety provisions are found in ☛ paragraphs 4.C.7. – 4.C.9.

7. Medical Department Representative Responsibilities. The presence of MSDs and their related equipment and facilities aboard ship increases the risk of exposure to untreated wastewater, which in turn increases the potential of an outbreak of infectious diseases associated with human waste. Since preventive medicine aboard ship is an integral part of the Medical Department's responsibility; MDRs must become knowledgeable with the MSD system aboard their ship; proper personal hygiene practices; and decontamination procedures involved in operating and maintaining MSD systems and to actively oversee safe, sanitary MSD operations and maintenance. The MDR must perform these duties:

   a. Visually inspect MSD components as described in ☛ Paragraph 4.C.3. as part of the routine habitability and sanitation inspection program or more frequently if the situation dictates. Whenever practical, inspect jointly with engineering personnel.

   b. Indoctrinate crew who operate, maintain, and repair MSD systems on the potential health hazards associated with human wastes, proper personal hygiene necessary to reduce the risks involved with working with MSDs, and correct procedures to clean and disinfect contaminated spaces. Conduct refresher training annually to ensure these personnel can operate and repair the MSD without endangering themselves or the ship's crew.

   c. When requested, advise on-site on the correct procedures to protect members and disinfect spaces after major sewage leaks or spills. The MDR must be present for cleaning and disinfecting food service spaces, living areas, and medical spaces.

8. CHT Systems' Safety and Health Hazards. A serious potential hazard of CHT systems is their release in confined spaces of toxic or explosive gases, most commonly hydrogen sulfide, and also possibly methane, ammonia, and carbon dioxide, among others. Follow these precautions to minimize the potential release of toxic gases.

   a. Operate the CHT tank aeration system while transiting the three-mile zone or in port while collecting sanitary wastes. Systems with tank capacities of fewer than 2,000 gallons do not require aeration systems; but because of the smaller tank capacity, the CHT discharge pumps will cycle more often while in port.

   b. Always assume the CHT tank contains sewage and toxic gases. Perform any maintenance requiring removing or disassembling valves, pumps, flanges, etc. inside the CHT pump room or below the CHT overflow to comply with ☛ NSTM, S9086-T8-STM-010, Chapter 593, Paragraphs 4.2.21.1. and 4.2.21.2.

   c. Crews working in the CHT pump room, comminutor space, or any space containing CHT piping must immediately evacuate the space if they detect hydrogen sulfide by its "rotten egg" smell or a personal portable hydrogen sulfide alarm. Personnel re-entering a space where hydrogen sulfide has been detected must wear air line respirators with full face masks.

d. Defer corrective maintenance not requiring immediate attention until the ship is in port and industrial facilities are available. If holding wastes presents a health or safety hazard, secure the system and file an engineering casualty report.

e. Smoking, eating, and/or drinking are prohibited inside CHT pump rooms and comminutor spaces or when working on any CHT component.

9. CHT Pump Room Safety. In most cases, CHT pumps are located in very small compartments on lower deck levels, providing an excellent collection basin for heavier-than-air gases, e.g., hydrogen sulfide. Follow these precautions to eliminate hazardous gas exposures in CHT pump rooms.

   a. Install slightly negative pressure ventilation, including powered air supply and exhaust ventilation extending to within 9 inches of the deck, in CHT pump rooms to comply with ☛ General Specifications for Ships of the United States Navy (GENSPECS), Section 512.

   b. Install an indicator light outside the compartment to indicate the ventilation system is operating.

   c. Place two emergency escape breathing devices (EEBD) in each CHT pump room.

   d. Use a portable hydrogen sulfide detector during all CHT maintenance.

   e. Post a placard with this message at access to the CHT pump room:

SEWAGE SPILLS PRODUCE
HAZARDOUS GASES

1. USE EEBD MOUNTED IN PUMP ROOM FOR EMERGENCY ESCAPE IF SEWAGE SPILLS.

2. FOLLOW SAFETY PROCEDURES IN ☛ NSTM, NAVSEA S9086-T8-STM-010, "POLLUTION CONTROL," CHAPTER 593, DURING SYSTEM MAINTENANCE OR SPILL CLEAN-UP.

3. USE APPROVED RESPIRATOR ONLY FOR EMERGENCY RESCUE AND DAMAGE CONTROL TO SECURE FLOODING.

   f. Post a safety watch with a spare OBA at the compartment access when performing any maintenance that requires opening the pump room system or in any space below the CHT tank overflow.

   g. Affix this label plate next to each CHT holding tank and sewage tank entrance:

WARNING

TOXIC OR EXPLOSIVE GASES MAY EXIST IN THIS TANK. DO NOT OPEN UNLESS AT A SUITABLE INDUSTRIAL ACTIVITY AND TANK HAS BEEN CERTIFIED GAS-FREE TO COMPLY WITH REQUIREMENTS OF ☛ NSTM, NAVSEA S98086-T8-STM-010, "POLLUTION CONTROL," CHAPTER 593.

D. Wastewater Treatment and Disposal Systems Ashore.

1. Introduction. A wide variety of methods is available to treat sewage, from simple settling techniques, e.g., cesspools, septic tanks, and Imhoff tanks, to sophisticated engineering systems defined by the level of sewage treatment they provide. These methods include:

   a. Primary treatment, with or without chemicals, is designed to remove a considerable portion of the suspended solids and colloidal substances, neutralize and equalize such substances, and prepare the wastewater for subsequent treatment or discharge.

   b. Secondary, or biological, treatment oxidizes the suspended and organic solids in solution that remain after primary treatment. The principal secondary methods are activated sludge and trickling filters; a third type is stabilization ponds, often used where large land areas are available and a high-quality effluent is not required.

   c. Tertiary, advanced, wastewater treatment removes pollutants conventional biological treatment processes, e.g., activated sludge, trickling filters, oxidation ponds, etc., do not. Such pollutants include suspended solids; Biological Oxygen Demand (BOD); refractory organics, reported as Chemical Oxygen Demand; nutrients, e.g., nitrogen and phosphorus; and inorganic salts.

   d. Water reclamation combines conventional and tertiary treatment processes to return wastewater to its original quality.

2. Individual Treatment Systems—Septic Tanks. Many Coast Guard shore facilities with small populations and where community sewerage is not available presently use septic tanks; however, a CO should obtain approval from the state or local sanitary commission before installing any new septic tank system. A septic tank (Figure 4-D) is a watertight, underground tank into which gravity deposits the raw sewage. Sewage flows into the tank; a series of baffles slows the flow, retaining the solids and allowing them to settle. During this retention period 50 to 70 percent of the solids suspended in the sewage may precipitate. The biological action of anaerobic and facultative bacteria then reduces the solids' volume, a process known as digestion, which destroys most of the pathogenic organisms. However the liquid effluent still may contain some pathogenic organisms and still will be putrescible. Through an opening near the top at the end opposite the influent the septic tank discharges effluent, which then disposed of through a network of concrete or clay pipe laid with open joints so the wastewater can percolate into and through the

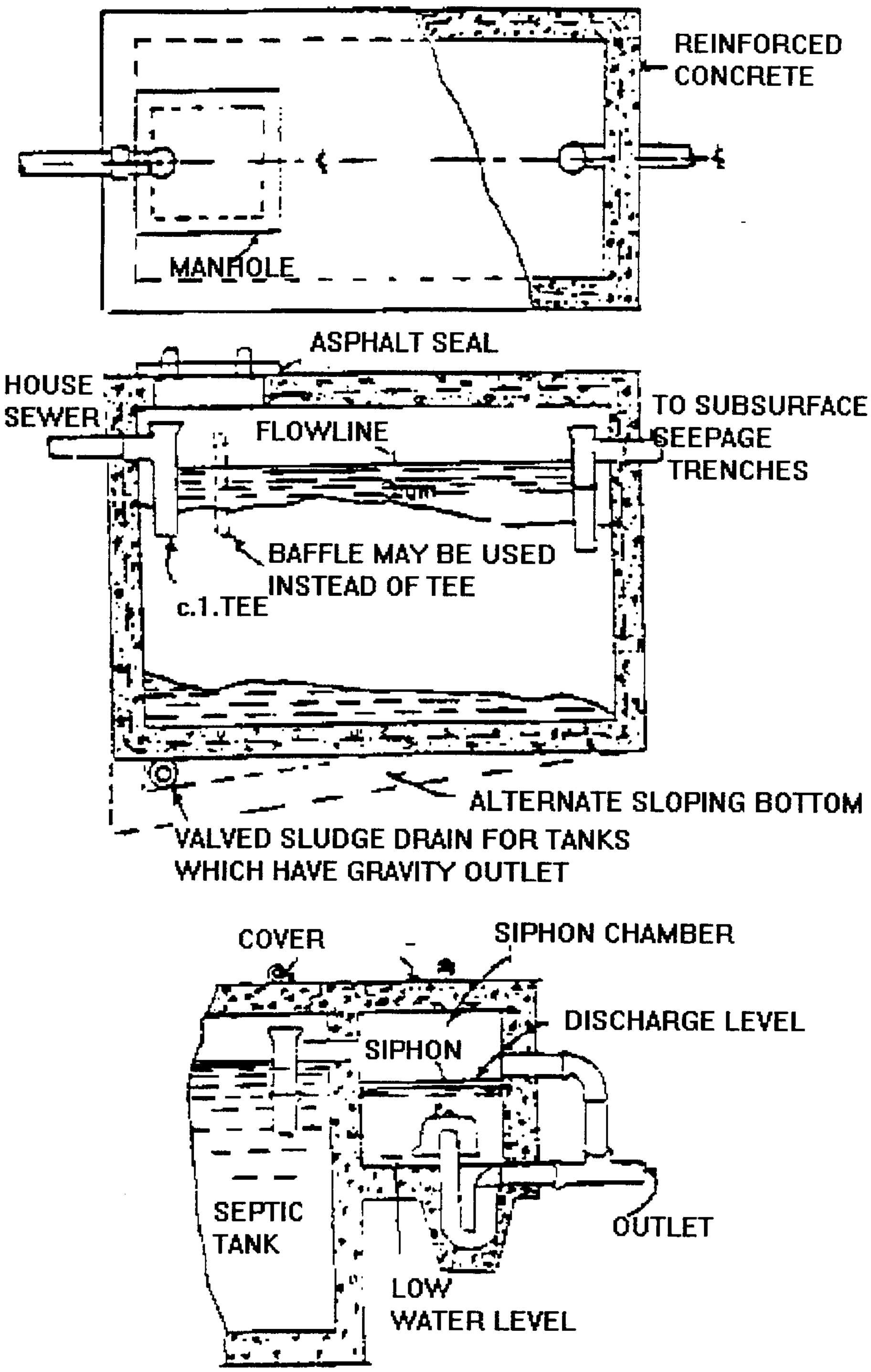

Figure 4-D: Typical Septic Tank

soil. Filtration then removes more suspended matter and aerobic bacteria in the soil help stabilize the organic matter remaining in the effluent. It is important the receiving soil field drains naturally, is permeable, and is sufficiently large. Heavy clay soils are not suitable. Avoid limestone formations, because fissures may allow unfiltered sewage to enter springs or wells.

a. <u>Inspections</u>. Inspect septic tanks periodically, with the frequency determined by the tank's capacity and the population load it serves. If a septic tank handles its design load or less, a semi-annual inspection usually is adequate. For heavier loads, inspect at two-month intervals. Inspections shall include these actions:

   (1) Measure accumulated solids (scum and sludge) as described in EPA's ☛ *Design Manual: On-site Wastewater Treatment and Disposal Systems*, available through the National Technical Information Service (stock number 219907).

   (2) Clear the inlet and outlet connections of any solids, including grease deposits, which tend to obstruct the sewage flow.

   (3) If the inlet or outlet baffle or the "T"-branch is missing, replacement is urgent.

   (4) Record each inspection in a log indicating date, sludge- and scum-free spaces, and the condition of the effluent water in the discharge outlet.

b. <u>Operation and Maintenance</u>. Septic tank operation and maintenance procedures must conform to ☛ *On-site Wastewater Treatment and Disposal Systems* requirements. The Engineering Department must arrange for removal of the septic tank's accumulated solids when the bottom of the floating scum mat is within 3 inches of the discharge pipe invert or the top of the settled sludge is within 12 inches of the invert.

c. In most areas, contractors are in business to remove the scum and sludge and dispose of it properly. Do not wash or disinfect the tanks after the solids have been removed. A small residue of solids is necessary for biological seeding purposes.

d. At isolated stations where contractors are not available, maintenance personnel must bail out the solids because they contain organisms that may endanger health unless properly removed. Burial in a pit located at least 100 feet downstream from any source of potable water is usually a satisfactory method of disposal. Always wear appropriate personal protective equipment, e.g., butyl rubber gloves, rubber boots, disposable coveralls, whenever exposed to sewage.

e. Septic tanks, distribution boxes, and tile absorption lines are not designed to support traffic or heavy overhead weight. The CO should prohibit traffic over these areas and mark the location or inform all motor vehicle, delivery truck, or other heavy equipment operators.

f. If chlorination is required, sample the liquid at the outlet from the chlorine contact chamber daily and test it for chlorine residual. Record the results in a daily log. If chlorine is not between 0.5 and 1.0 ppm at peak flow, the system operator must adjust the chlorine dosage accordingly.

3. Community Wastewater Treatment Systems.

a. Primary Treatment. Primary treatment is designed to remove the suspended solids from raw wastewater (Figure 4-E) by mechanical means such as screening and sedimentation; however, additional treatment is required before the wastewater meets EPA and state effluent standards.

(1) Screening. Various screens remove large solids that could clog or damage pumps or otherwise hinder the sewage flow through the plant from influent wastewater. Various forms of screening devices, depending on the existing conditions at each locality and plant design, include racks and bar screens to intercept large debris; perforated plates and fine screens to remove smaller objects; and comminutors and cutting screens to reduce the solids' size.

(2) Wet Wells. Where present, wet wells collect the fluctuating flow of influent wastewater and feed it through the system at a relatively even rate to regulate flow through the treatment system.

(3) Grit Chambers. Grit chambers are designed to remove sand and other solids that may damage pumps and valves, accumulate in sedimentation tanks, or clog sludge drains. Grit chambers are particularly important in plants receiving wastewater from combined storm and sanitary sewers since this effluent contains a great deal of gritty material. The grit precipitates when the wastewater velocity decreases sufficiently so the heavy inorganic materials settle while the organic solids remain suspended. A plant usually has two grit chambers arranged in parallel so one can operate while the other is cleaned. Removed from the chamber either manually or mechanically, the washed grit is relatively inoffensive and can be used in landfills.

(4) Sedimentation Tanks. Sedimentation is used in both primary and secondary treatment processes; when employed in a primary treatment process, it is called "primary sedimentation." Sedimentation removes of a large number of suspended solids from the raw wastewater. Plain sedimentation and chemical precipitation are two types of sedimentation used to treat wastewater.

(a) Plain sedimentation with separate sludge removal is a common practice. The influent enters a circular or rectangular sedimentation tank (Figure 4-F) where a system of baffles, weirs, and multiple inlets slows and distributes the flow rate evenly across the tank. The slow, even flow allows solids to settle to the bottom of the tank as sludge; hydrostatic pressure or suction pipes remove it from the tank to a digester to prevent the sludge from decomposing, which would release to the surface gases that would hinder effective settling and produce noxious odors.

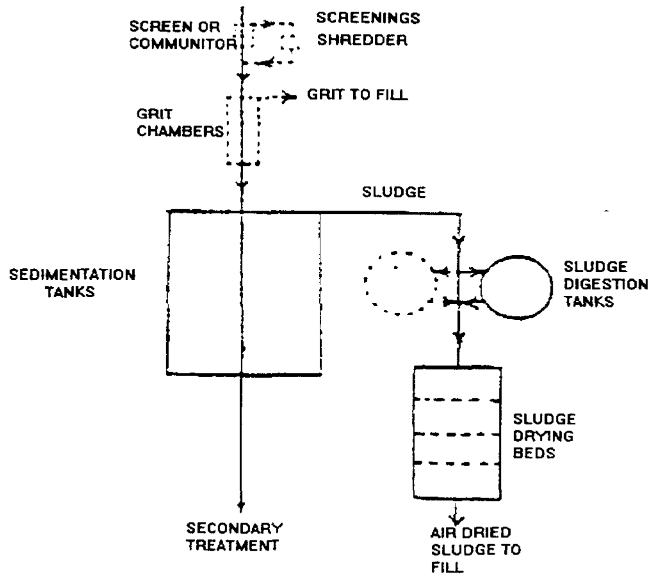

Figure 4-E: Schematic diagram of primary sewage treatment.

(b) Chemical precipitation sometimes is used to enhance the settling process. In this method chemicals, e.g., lime, alum, ferrous sulfate, and/or ferric chloride, are added to the wastewater before it enters the sedimentation tank. As the chemicals mix with the wastewater they form an insoluble, gelatinous "floc" that rapidly settles, carrying with it most of the wastewater's suspended solids. This method is most often used to treat industrial wastewater.

(c) Most sedimentation tanks have mechanical skimming devices to remove scum and oil products that float on the wastewater's surface.

(d) The sedimentation tank's outlet weir extends either across the full width of rectangular sedimentation tanks or around the periphery of circular ones to ensure a smooth, even flow. The effluent continues on to secondary treatment or final disposition.

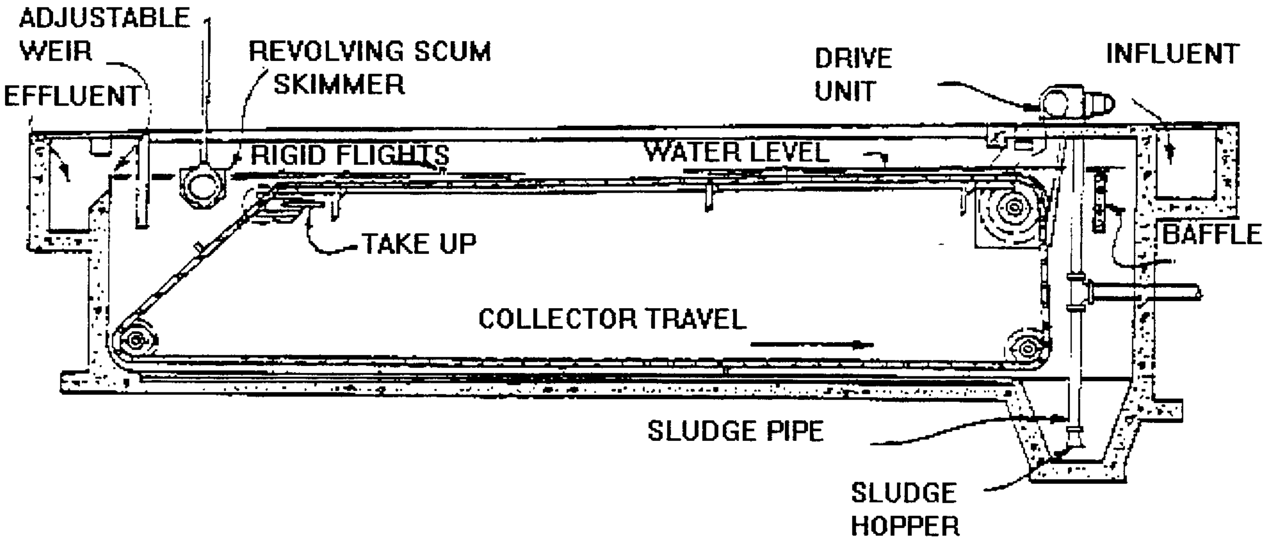

Figure 4-F: Rectangular sedimentation tank, chain sludge collector

(5) Efficiency. Primary treatment removes only a portion of suspended substances, leaving colloids and dissolved solids in the liquid effluent. Depending on the concentration, retention time in the sedimentation tank, and evenness of flow and distribution in the tank, primary treatment removes 40 to 75 percent of the suspended matter and reduces the BOD 30 to 40 percent.

b. Secondary Treatment. Secondary treatment removes most colloidal and dissolved organic materials in wastewater, usually under aerobic conditions by biological oxidative decomposition and production of biological growths then removed in secondary sludge. Activated sludge, trickling filters, and stabilization ponds most often maintain aerobic conditions and the intimate contact between the wastewater and organisms necessary to remove pollutants.

(1) Activated Sludge.

(a) In the activated sludge process (Figure 4-G), primary sedimentation effluent continually flows into an aeration chamber where it mixes with sludge aerated and thereby "activated" with aerobic bacteria to form a mixed liquor. Compressed air applied through diffusers or jets at the bottom of the aeration tank or by a stirring device thoroughly agitates the mixed liquor so it can absorb air from the atmosphere.

(b) The primary agents in the activated sludge process are aerobic bacteria, with secondary feeders called holozoic protozoa also playing an essential role. In activated sludge primary bacteria in the "endogenous" or declining-growth phase die and dissolve, releasing their cell contents into the solution. In doing so, various bacteria groups continuously synthesize organic matter. Holozoic

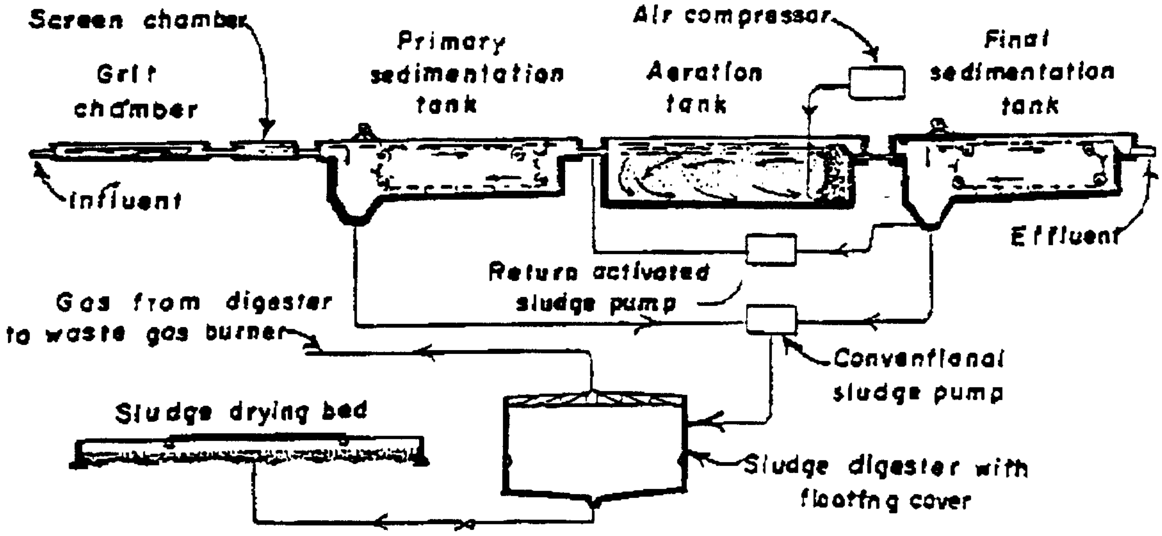

Figure 4-G: Cross section of a secondary treatment plant using activated sludge treatment.

protozoa live in a predator-prey relationship, assisting in the continued removal of the bacteria, further stimulating bacterial growth, accelerating extraction of organic matter from solution. In addition, reducing the number of free-floating bacteria in the solution improves the activated sludge's flocculation (clumping) characteristics. The better-developed these are, the faster the sludge settles.

(b) A portion of the sludge volume continually recirculates from the secondary sedimentation tank or clarifier to the aeration chamber to ensure the tank maintains adequate levels of biological activity. In addition, recirculation allows the additional breakdown of organic materials in the sludge.

(c) Under proper conditions the activated sludge process is very efficient, removing 85 to 95 percent of the solids and reducing the BOD by the same percentage. Activated sludge systems' efficiency depends on many factors, including climate and wastewater characteristics. Toxic industrial wastes can disrupt these systems' biological activity; heavy soap or detergent wastes can cause excessive frothing and thereby create esthetic or nuisance problems. In areas where industrial and sanitary wastes combine, industrial wastewater often must be pre-treated to remove the industrial and chemical toxins before undergoing activated sludge treatment.

(2) Trickling Filters.

(a) The trickling filter (Figure 4-H) is a system designed to reduce BOD through biological action on dissolved organic and finely divided solids. Usually the filter bed (Figure 4-I) is circular. Rotating arms evenly spray liquid sewage over the bed's upper surface from a height of about 12 inches to distribute influent equally over the entire filter bed surface.

(b) Filter packing typically is composed of 2½- to 4-inch rocks 3 to 8 feet deep in circular tanks. More recent constructions use a plastic packing material up to 40 feet deep. The filter bed is constructed with an underdrain system that removes the effluent to secondary sedimentation basins and allows air to circulate freely throughout the bed to support the growth of aerobic bacteria and other organisms on which the process depends.

(c) The active portion of the trickling filter system is the biological slime—zooglea, consisting of layers of bacteria, protozoa, and fungi—that forms on the rocks. In addition, in optimum temperatures and sunlight the bed's surface may support algae growth, while the depths frequently support nitrifying bacteria growth. Nitrification is an aerobic process in which oxygen in the air acts on ammonia from the sewage to form nitrate and carbon dioxide. The more vigorous the nitrification, the more it reduces the nitrogenous oxygen demand downstream in the receiving water. As the sewage flows down through the filter bed, the jelly-like layer of living organisms digests or oxidizes the suspended and colloidal organic solids remaining after primary treatment. As the zooglea layer builds up, air is not able to penetrate its thickness. Anaerobic bacteria develop between the film and rocks, creating gas that loosens the zooglea, which falls free and flows into the secondary sedimentation basin, where it settles and contributes to sludge formation. Aerobic bacteria then develop again on the rock surface and the process repeats. This self-cleaning process makes the trickling filter a very economical, efficient form of treatment. However, this type of system is not readily adaptable where the climate includes severe winter conditions.

(d) The two types of trickling filters currently in use are the standard and high-rate. The raw wastewater entering the plant intermittently doses the standard trickling filter, while the high-rate filter is dosed continuously. High-rate filtration is accomplished by recirculating a portion of the liquid from the filter, which increases the efficiency of the process by preventing the beds from drying out and maintaining the optimum amount of zooglea. Continuous dosing also reduces other problems, e.g., fly breeding, freezing, and odors.

(e) As noted in Figure 4-H, wastewater flows from the trickling filter tank into the secondary sedimentation tank, where large volumes of sludge settle from the wastewater. The effluent then travels to a chlorine contact disinfection tank and is discharged to a receiving body of water. Sludge is continually removed form both primary and secondary settling basins and processed for disposal.

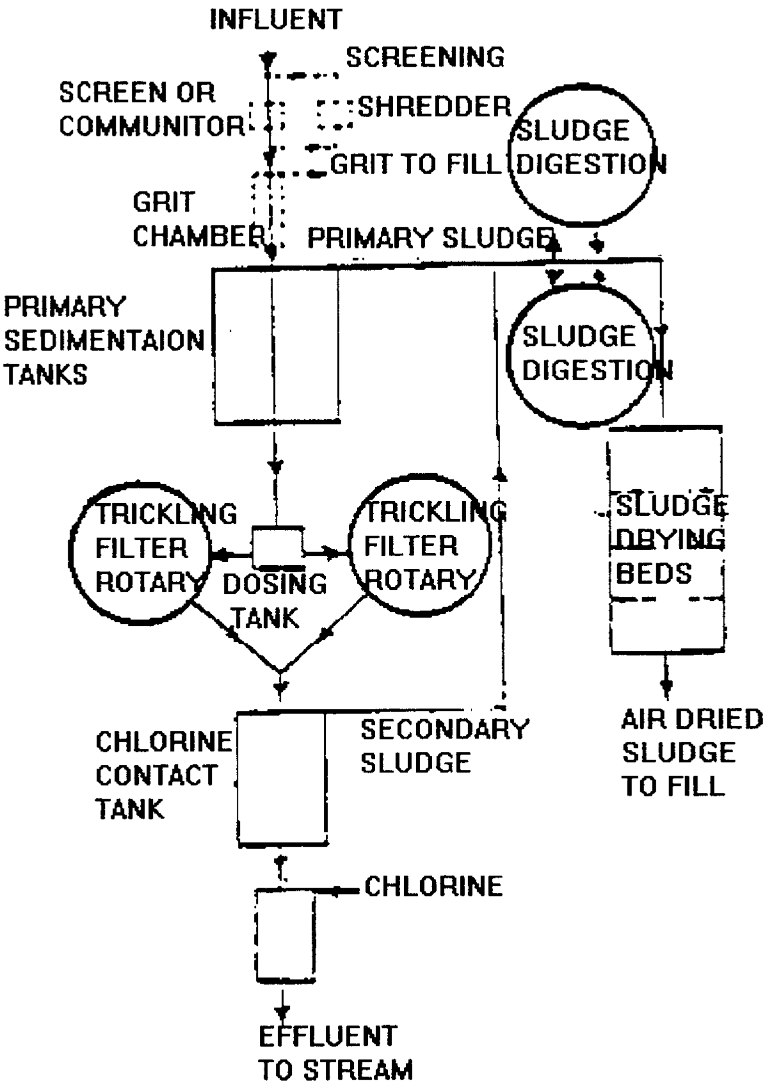

Figure 4-H: Schematic flow diagram of secondary treatment with trickling filter.

(f) Filter flies (*Psychoda*) often become a nuisance. To control them, weekly or biweekly close the effluent drain and flood the filter to a depth of 4 inches above the rock surface for 24 hours. To be effective continuously, the filter must be flooded frequently enough to prevent the flies from completing their life cycle between flooding.

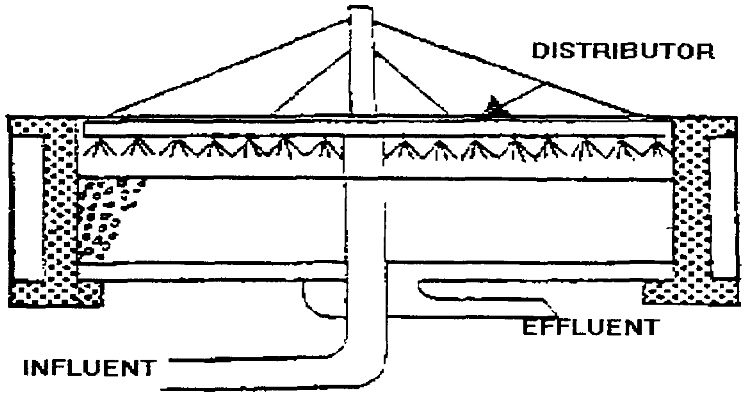

Figure 4-I: Cross section of trickling filter.

c. Tertiary Treatment. Tertiary treatment may consist of additional intermittent or contact filtering stages; or prolonged retention in an oxidation pond; or a special chemical treatment designed to precipitate, neutralize, or oxidize a particular pollutant; or effluent chlorination before final discharge into receiving waters.

d. Disinfection.

(1) Chlorination. Normally chlorine is added to sewage for two reasons: pre-chlorination controls the hydrogen sulfide in sewage and final chlorination disinfects, i.e., destroys pathogenic bacteria and other undesirable biological life in the effluent.

(a) Adding chlorine to wastewater before actual treatment serves two purposes. As an active oxidizing agent, chlorine breaks down the hydrogen sulfide, reducing its potential to mix with water and form sulfuric acid, which would promote noxious odors and corrosion in the wastewater. If pre-chlorinating, it is important to add the correct amount: too much free residual chlorine may interfere with the secondary treatment system's biological processes.

(b) Chlorine's strong oxidizing power degrades the bacterial cell's chemical structure, destroying the enzymatic processes needed for life. Wastewater disinfection is defined as adding enough chlorine to create a free chlorine residual of between 0.5 ppm and 0.7 ppm after a 30-minute contact time. The amount of chlorine required to maintain this residual varies greatly depending on the wastewater's composition, temperature, and flow rate. To maintain uniform results, monitor and adjust the chlorine flow frequently.

(2) When treating wastewater, other chemicals, including bromine, iodine, and ozone, occasionally are used as disinfecting agents. More often these chemicals are used to treat swimming pools, spas, and/or drinking water. Chlorine is still the most effective way to disinfect domestic wastewater.

4. Grease Interceptors (Traps). Grease traps—tanks installed in sewer lines with the inlet and outlet fittings located below the liquid level—reduce grease and scum accumulation in sewer lines and primary treatment tanks. The grease trap must be large enough to remove the grease through gravity, i.e., differential separation. Trap capacity and design should conform to the recommendations in ☛ *On-site Wastewater Treatment and Disposal Systems*. Site the grease trap where it can be easily inspected and cleaned. Inspect the trap frequently and clean it when the grease volume reaches 75% of retention capacity. If possible, sell the grease to rendering companies (to make soap and glycerin); otherwise dispose of it with the garbage. Tightly cover grease traps to prevent nuisance odors and exclude insects and vermin. **Note**: Do not discharge waste from a garbage grinder into a grease trap. Do not site grease traps where they could collect human wastes.

5. Classification. To assist in determining whether an existing or proposed system provides "primary", "secondary", or "tertiary" treatment, this table shows the more common treatment system classifications:

Treatment System Classifications

SYSTEM TYPE	TREATMENT TYPE
Septic Tank	Primary
Septic Tank with Chlorinator	Primary
Imhoff Tank	Primary
Imhoff Tank with Chlorinator	Primary
Settling Tank, with or without Chlorinator	Primary
Cesspool	Primary
Mascerator-Disinfector	Primary
Trickling Filter	Secondary
Septic Tank with Absorption Field	Secondary
Imhoff Tank Followed by Filtration	Secondary
Intermittent Sand Filter *	Secondary
Activated Sludge *	Secondary
Extended Aeration *	Secondary
Contact Stabilization *	Secondary
Nitrate Precipitation	Tertiary
Phosphate Precipitation	Tertiary
Retention in Oxidation Pond	Tertiary
* Followed by Sedimentation or Clarification	

6. Industrial Wastewater Treatment and Disposal.

   a. Industrial wastewater characteristics vary as widely as industrial processes. Industrial wastes include organic chemicals, e.g., chlorinated hydrocarbons and phenols; corrosive wastes, e.g., acids and alkalis; toxic chemicals, e.g., cyanide and heavy metals; greases and oils; radioactive wastes; thermal pollution; and many others. Many industrial wastes can greatly disrupt domestic wastewater treatment systems by inhibiting or otherwise interfering with treatment processes and causing major sludge handling and disposal problems. In addition, these wastewaters can adversely affect the quality of the receiving waters into which discharged.

b. Inform the Area Maintenance and Logistics Command (s) or Civil Engineering Unit about problems in treating and disposing of industrial wastewaters at Coast Guard facilities. The regulating authority may impose severe penalties for improper disposal.

7. Health Precautions for Wastewater Treatment System Personnel.

a. Personnel in contact with wastewater or who work in or inspect wastewater treatment plants must keep their basic required immunizations, including polio, tetanus, hepatitis A, and diphtheria, current.

b. Wastewater treatment plant personnel must not eat, drink, or smoke when maintaining or inspecting possibly contaminated equipment.

c. After a wastewater spill, personnel cleaning the area must wear coveralls, rubber boots, rubber gloves, hair coverings, and face shields. Promptly after completing spill clean-up, clean-up personnel must remove contaminated clothing and place it in a plastic bag for laundering and then take a hot shower, using plenty of soap and water.

d. Clean-up personnel must exercise caution when cleaning sewage spills in confined spaces. Sewage can emit explosive or toxic gases that can displace the oxygen in the space. Personnel must be familiar with and follow the requirements of ☛ the Shore Confined Space Entry Manual, COMDTINST 5100.48. Clean wastewater spill areas with detergent and water; then rinse thoroughly. In food service, berthing, and medical spaces, disinfect the spill area. Disinfecting also may help to prevent odors. ☛ Paragraph 4.C.5.l. lists recommended disinfectants.

e. Immediately on a major leak or spill, notify the Medical Department Representative.

8. Medical Department Responsibilities.

a. Semi-annually inspect wastewater treatment facilities to detect potential health hazards to operators and the surrounding community.

b. Be alert to any increase among treatment plant operators or surrounding community members in disease incidence attributable to exposure to human wastes.

Appendix 4.A. CHT Maintenance and Sewage Spill Clean-Up Equipment

ITEM DESCRIPTION	NSN	QUANTITY
Bag, Plastic	9Q 8105-00-070-9496	1Box, 100 Count
Boots, Rubber, Size 7	9D 8430-00-147-1033	SEL
Boots, Rubber, Size 8	9D 8430-00-147-1034	SEL
Boots, Fireman's, Size 11	9D 8430-00-299-0342	SEL
Boots, Fireman's, Size 9	9D 8430-00-147-1035	SEL
Bucket, Mop, 16 Qt.	9Q 7920-00-926-5243	3
Coveralls, Disposable, LG	9D 8415-00-601-0801	SEL
Coveralls, Disposable, MED	9D 8415-01-092-7530	SEL
Coveralls, Disposable, LG	9D 8415-01-092-7531	SEL
Coveralls, Disposable, XLG	9D 8415-01-092-7532	SEL
Coveralls, Disposable, XXLG	9D 8415-01-092-7533	SEL
Coveralls, Disposable, LG	9D 8415-00-601-0797	SEL
Coveralls, Disposable, MED	9D 8415-00-601-0794	SEL
Coveralls, Disposable, SM	9D 8415-00-601-0793	SEL
Coveralls, Disposable, XXLG	9D 8415-00-601-0802	SEL
Coveralls, Disposable, SM	9D 8415-01-092-7529	SEL
Detergent, General Purpose	9Q 7930-00-515-2477	1 GAL
Disinfecting Detergent, Liquid	9G 6840-00-598-7326	1 GAL
Disinfectant, General	9Q 6840-00-782-2691	1 GAL
Gloves, Rubber Toxicological	9D 8415-00-753-6551	SEL
Gloves, Toxicological, MED	9D 8415-00-753-6552	SEL
Gloves, Toxicological, LG	9D 8415-00-753-6553	SEL
Gloves, Toxicological, XLG	9D 8415-00-753-6554	SEL
Goggles, Ind, Clear	9G 4240-00-190-6432	3 PAIR
Handle, Mop	9Q 7920-00-205-1170	1
Mophead, Sponge	9Q 7920-00-728-1167	3
Mophead, Wet	9Q 7920-00-141-5549	2
Pail, All-Purpose	9Q 7240-00-754-1298	1
Povidine-Iodine Solution	9L 6505-00-914-3593	1 BOX
PP-Boots-Hip, Size 10	9D 8430-00-147-1036	SEL
PP-Boots-Hip, Size 12	9D 8430-00-147-1038	SEL
Respirator, Air Filt	9G 4240-01-268-6756	3
Wringer, Mop	9Q 7920-00-265-7056	1
PP Breathing Apparatus A-4	3HD4240-00-616-2857	3

Notes:

1. If respiratory protection is required, see ☛ NSTM, S9086-T8-STM-010, Chapter 593, for details. Use existing on-board respirators when performing CHT maintenance.
2. Required are enough coveralls, gloves, and boots to support two (2) persons who normally conduct routine CHT maintenance and minor spill clean-ups.
3. Store all items in a locked gear locker to prevent pilferage.

Treated Water Quality Standards

Table 1.1. National Primary Drinking Water Regulations (NPDWR) Maximum Contaminant Levels (MCLs) for Inorganic Chemicals

CONTAMINANT	MCLG [1] (mg/L)	MCL (mg/L)	AL [2] (mg/L)
Asbestos	7 million fibers/L longer than 10 micrometers	7 million fibers/L longer than 10 micrometers	
Arsenic		0.050	
Barium	2.0	2.0	
Cadmium	0.005	0.005	
Chromium	0.1	0.1	
Copper	1.3		1.3 [3]
Fluoride	4.0	4.0	
Lead	0	0	0.015 [4]
Mercury	0.002	0.002	
Selenium	0.050	0.050	
Nitrate (as N)	10.0	10.0	
Nitrite (as N)	1.0	1.0	
Total Nitrate *and* Nitrite (as N)	10.0	10.0	

[1] Maximum Contaminant Level Goal (MCLG). The maximum amount of a contaminant in drinking water at which no known or anticipated adverse effect on persons' health would occur plus an adequate margin of safety. Maximum contaminant level goals are not enforceable health goals.

[2] Action Level (AL). Concentrations of lead or copper in water that determine in some cases whether a water system must install corrosion control treatment, monitor source water, replace lead service lines, and undertake a public education program. Consult with the area MCL (kse) for details.

[3] The copper action level is exceeded if the concentration of copper in more than 10 percent of properly collected tap water samples during any monitoring period is greater than 1.3 mg/L, i.e., if the "90th percentile" copper level is greater than 1.3 mg/L. Consult with the area MCL (kse) for details.

[4] The lead action level is exceeded if the concentration of lead in more than 10 percent of tap water samples properly collected during any monitoring period is greater than 0.015 mg/L, i.e., if the "90th percentile" lead level is greater than 0.015 mg/L. Consult with the area MCL (kse) for details.

Table 1.2. National Primary Drinking Water Regulations (NPDWR) Maximum Contaminant Levels (MCLs) for Organic Chemicals, Pesticides, and PCBs		
CONTAMINANT	**MCLG (mg/L)**	**MCL (mg/L)**
Endrin	0.0020	0.0020
Lindane	0.0002	0.0002
Methoxychlor	0.0400	0.0400
Toxaphene	0.0000	0.0030
2,4-D	0.0700	0.0700
2,4,5-TP Silvex	0.0500	0.0500
Alachlor	0.0000	0.0020
Atrazine	0.0030	0.0030
Carbofuran	0.0400	0.0400
Chlordane	0.0000	0.0020
1,2-Dibromo-3-chloropropane (DBCP)	0.0000	0.0002
Ethylene dibromide (EDB)	0.0000	0.00005
Heptachlor	0.0000	0.0004
Heptachlor epoxide	0.0000	0.0002
Polychlorinated biphenyls (PCBs) (as decachlorbiphenyl)	0.0000	0.0005
Aldicarb	0.0010	0.0030
Aldicarb sulfoxide	0.0010	0.0040
Aldicarb sulfone	0.0010	0.0020
Pentachlorophenol	0.0000	0.0010
Total Trihalomethanes[1] (sum of concentrations of Bromo-dichloromethane, Dibromochloromethane, Tribromomethane (bromoform), and Trichloromethane (chloroform)	none	0.1000

[1] The MCL for total trihalomethanes applies only to water systems serving 10,000 or more persons and adding a disinfectant to the water. For systems serving fewer than 10,000 persons, check with the state health authorities to determine the MCL.

Table 1.3. National Primary Drinking Water Regulations (NPDWR) Maximum Contaminant Levels (MCLs) for Volatile Organic Compounds (VOCs)		
CONTAMINANT	**MCLG (mg/L)**	**MCL (mg/L)**
Benzene	0.0000	0.0050
Carbon tetrachloride	0.0000	0.0050
1,2-dichloroethane	0.0000	0.0050
1,1-Dichloroethylene	0.0070	0.0070
para-Dichlorobenzene	0.0750	0.0750
1,1,1-Trichloroethane	0.2000	0.2000
Trichloroethylene	0.0000	0.0050
Vinyl chloride	0.0000	0.0020
o-Dichlorobenzene	0.6000	0.6000
cis-1,2-Dichloroethylene	0.0700	0.0700
trans-1,2-Dichloroethylene	0.1000	0.1000
1,2-Dichloropropane	0.0000	0.0050
Ethylbenzene	0.7000	0.7000
Monochlorobenzene	0.1000	0.1000
Styrene	0.1000	0.1000
Tetrachloroethylene	0.0000	0.0050
Toluene	1.0000	1.0000
Xylenes (total)	10.0000	10.0000

1. Turbidity. The MCL for turbidity applies to both community and non-community water systems wholly or partly using surface water sources. The MCL for turbidity in drinking water measured at representative entry point(s) to the distribution system is:

    a. One turbidity unit for monthly average (5 turbidity units monthly may apply at State option).

    b. Five turbidity units (maximum) average for two consecutive days.

2. Coliform Bacteria.

    a. The MCL for coliform bacteria (also called total coliforms) is based on the presence or absence of coliforms in a sample.

        (1) The MCL for systems analyzing at least 40 samples each month is a maximum of 5 percent of the monthly samples may be total coliform positive.

        (2) The MCL for systems analyzing fewer than 40 samples per month is a maximum of 1 sample per month may be total coliform positive.

b. A public water system must demonstrate compliance with the MCL for total coliforms each month it is required to monitor.

c. The command must report MCL violations to the State by the end of the next business day after the operator learns of the violation.

d. Monitoring Requirements for Total Coliforms:

(1) Each public water system must follow a written sampling plan subject to State review and revision. The State must establish a process that assures the written sampling plan's adequacy for each system.

(2) The operator must collect a set of repeat samples for each total coliform positive routine sample and have it analyzed for total coliforms. At least one repeat sample must be from the same tap as the original total coliform positive sample; the operator must collect other repeat samples from within five service connections—at least one upstream and another downstream—of the original total coliform positive sample. The operator must collect all repeat samples within 24 hours after the testing lab has notified the water system of the original result, unless the State waives this requirement individually. If a total coliform positive sample is at the end of the distribution system, the State may waive the requirement to collect at least one repeat sample upstream of the original sampling site.

(3) If the testing lab detects total coliforms in any repeat sample, the operator must collect another set of repeat samples as before, unless the count violates the MCL and the system has notified the State; if so the State may reduce or eliminate the requirement to take the remaining samples.

(4) If a system has only one service connection, a State may allow it to collect the required set of samples at the same tap over a four-day period or to collect a larger volume repeat sample(s), e.g., a single 400 ml sample.

(5) If a system is required to collect fewer than five samples a month and the testing lab detects total coliforms in any routine or repeat sample (and the State does not invalidate it), the system must collect a set of five routine samples the next month it provides water to the public. The State may waive this requirement if: (1) it visits the site to evaluate the contamination problem, or (2) it has determined why the sample was total coliform-positive and:

(a) This finding and the actual or proposed action the system will take to correct the problem are documented in writing before the end of the next month the system serves water to the public,

(b) The supervisor of the State official who makes the findings signs this document,

(c) The document is available to EPA and the public and

(d) In certain cases described in this rule, the operator collects at least one additional sample.

(6) Systems using unfiltered surface or ground water under the direct influence of surface water must have one coliform sample analyzed each day the source's turbidity exceeds one NTU (this sample counts toward the system's minimum monitoring requirements).

(7) Monthly monitoring requirements are based on populations served. Tables 2.4. and 2.5. summarize the routine and repeat sampling requirements for total coliforms.

Table 1.4. Total Coliform Sampling Requirements According to Population Served

POPULATION SERVED[1]	MINIMUM NUMBER OF ROUTINE SAMPLES PER MONTH
25 to 1,000	1
1,001 to 2,500	2
2,501 to 3,300	3
3,301 to 4,100	4
4,101 to 4,900	5
4,901 to 5,800	6
5,801 to 6,700	7
6,701 to 7,600	8
7,601 to 8,500	9
8,501 to 12,900	10
12,901 to 17,200	15
17,201 to 21,500	20
21,501 to 25,000	24
25,001 to 33,000	30
33,001 to 41,000	40
41,001 to 50,000[2]	50

[1] For non-community water systems, see ☛ NPDWR.
[2] For community water systems serving more than 50,000, see ☛ NPDWR.

Table 1.5. Monitoring Requirements After a Positive Total Coliform Sample		
NUMBER OF ROUTINE SAMPLES/MONTH	NUMBER OF REPEAT SAMPLES[1]	NUMBER OF ROUTINE SAMPLES NEXT MONTH[2]
1	4	5
2	3	5
3	3	5
4	3	5
5	3	No additional required[3]

[1] Number of repeat samples in the same month for each total coliform-positive routine sample.

[2] Except where the state: invalidates the original routine sample; substitutes an on-site evaluation of the problem; or waives the requirements on an individual case basis. See ☛ 40 CFR 141.21a(b)(5) for more details..

[3] Systems need not take any additional samples beyond those normally required.

e. Invalidating Total Coliform Positive Samples.

(1) Each total coliform-positive sample counts in compliance calculations, unless the State invalidates it. Invalid samples do not count toward the minimum monitoring frequency.

(2) A State may invalidate a sample only under these conditions:

(a) The analytical laboratory acknowledges improper analysis caused the positive result;

(b) The system determines the contamination is a domestic or non-distribution system plumbing problem on the basis that one or more repeat samples taken at the same tap as the original positive sample is total coliform-positive, but all repeat samples at nearby sampling locations are total coliform negative; or

(c) The State has substantial grounds to believe a total coliform-positive result is due to some circumstance or condition not reflecting water quality in the distribution system and documents the basis for this determination in writing, the supervisor of the State official who so determined signs and approves this document, and the command makes the document available to EPA and the public.

f. Variances and exemptions are not allowed.

3. Sanitary Surveys. EOs must perform periodic sanitary surveys for all systems collecting fewer than 5 samples per month; Table 1.6. has details.

Table 1.6. Sanitary Survey Frequency for Public Water Systems Collecting Fewer than 5 Samples per Month		
SYSTEM TYPE	**INITIAL SURVEY COMPLETED BY**	**FREQUENCY OF SUBSEQUENT SURVEYS**
Community Water System	29 June 1994	Every 5 years[1]
Non-community Water System	29 June 1999	Every 5 years[2]

[1] 40 CFR 141.71b also requires annual on-site inspection of a system's watershed control program and reliability of disinfection practices for systems using unfiltered surface water or groundwater under the direct influence of surface water. While the annual on-site inspection is not equivalent to the sanitary survey requirements of the 40 CFR 141.21a(d) coliform rule, a sanitary survey during a year can substitute for the annual on-site inspection for that year.

[2] A non-community water system using only protected, disinfected groundwater repeats the sanitary survey every 10 years.

4. Fecal Coliforms/*E.coli*.

   a. If any routine or repeat sample is total coliform-positive, the system must analyze the total coliform-positive culture to determine if fecal coliforms are present, except the system may test for *E. coli* in lieu of coliforms. If testing detects fecal coliforms or *E. coli*, the system must notify the State before the end of the same business day, or if the State office is closed, by the end of the next business day.

   b. If any repeat sample is fecal coliform or *E. coli*-positive, or if a repeat sample shows a total coliform-positive result after the original sample showed fecal coliform or *E. coli*, and if both samples are valid, the system violates the MCL for total coliforms, an acute violation.

   c. The State has the option to allow an individual water system to forgo fecal coliform or *E. coli* testing on total coliform-positive samples if the system treats every total coliform-positive sample as if it contained fecal coliforms, i.e., the system complies with all applicable requirements for fecal coliform-positive results.

   d. If the State invalidates a total coliform-positive sample, that action invalidates subsequent fecal coliform or E. coli positive results on the same sample.

5. Heterotrophic Bacteria. Heterotrophic bacteria can interfere with total coliform analysis. Therefore, if the total coliform sample produces one of the results below, within 24 hours of notice of these results, the system must collect another sample from the same location as the original and have it analyzed for total coliforms. In such case, EPA recommends using

media less prone to interference from heterotrophic bacteria for the replacement sample analysis. The State may waive the 24-hour time limit on an individual basis.

a. using the MTF; a turbid culture in the absence of gas production;

b. using the P-A; a turbid culture in the absence of an acid reaction;

c. using the MF, confluent growth or colony number "too numerous to count" the sample is invalid (unless total coliforms are determined, if so, the sample is valid)

6. Analytical Methodology.

a. Total coliform analyses are to be conducted using the 10 tube MTF, the MF, the P-A or the Colilert Test (MMO-MUG test). A system may also use the 5 tube MTF technique (using 20 ml sample portions) of a single culture bottle containing the MTF medium, as long as a 100 ml sample is used in the analysis.

b. Regardless of the analytical method, use a 100 ml standard sample volume in analyzing for total coliforms.

c. Use methods described in 40 CFR 141.21 and *Standard Methods* to analyze for fecal coliforms. Obtain *Standard Methods* from:

American Public Health Association
1015 – 15th Street, N.W.
Washington, D.C. 20005

d. Use methods described in the 8 Jan 91 *Federal Register* (56 FR 642) and/or *Standard Methods* to analyze for *E. coli.*

7. Radiological Contaminants.

Table 1.7. Maximum Contaminant Level for Radiological Contaminants[1]	
Gross alpha particle activity including Radium-226, excluding radon and uranium	15 pCi/L
Combined Radium-226 and Radium-228	5 pCi/L
Tritium	20,000 pCi/L
Strontium-90	8 pCi/L

[1] The EPA has established screening indicators for radiological contaminants. As an indicator, gross alpha present at less than or equal to 5 pCi/L eliminates the need to analyze for Radium-226 and Radium-228. As an indicator, gross beta present at less than or equal to 8 pCi/L eliminates the need to analyze for Tritium and Strontium-90.

8. Sodium and Corrosion. No MCLs have been published; however, monitoring is required.

Table 1.8. National Secondary Drinking Water Regulations (NSDWR)[1]	
CONTAMINANT	**LEVEL**
Aluminum	0.05 to 0.2 mg/L
Chloride	250 mg/L
Color	15 color units
Copper	1.0 mg/L
Corrosiveness	Non-corrosive
Fluoride	2.0 mg/L
Foaming agents	0.5 mg/L
Iron	0.3 mg/L
Manganese	0.05 mg/L
Odor	3 threshold odor number
pH	6.5 to 8.5
Silver	0.1 mg/L
Sulfate	250 mg/L
Total Dissolved Solids (TDS)	500 mg/L
Zinc	5 mg/L

[1] This regulation covers contaminants that may adversely affect drinking water's aesthetic quality. These secondary levels represent reasonable goals for drinking water quality, but are not Federally enforceable. Individual states may establish higher, lower, or no levels for these contaminants.

Chlorine Solutions and Concentrations

1. Preparing Chlorine Solutions. Manufacturer's instructions may specify using a particular type of chlorine solution in their equipment. However, any of these solutions may be used if properly prepared.

   a. Sodium Hypochlorite. Sodium hypochlorite requires no preparation. Use it directly as it comes from the container.

   b. Calcium Hypochlorite. Place the proper amount of calcium hypochlorite in a clean, dry container. Add water and stir until the powder is dissolved. Allow the solution to stand for a few minutes so any undissolved particles can settle to the bottom. Pour off the clear liquid and discard the residue. Disregard any slight turbidity in the water.

2. Chlorine Solution Preparation Tables.

   a. The Chlorine Dosage Calculator shows the amount of each chlorine compound or solution to add to water to produce the most commonly used chlorine concentrations. The amount of chlorine remaining after a given time depends on the amount of organic matter and other foreign material in the water. Only sampling and testing the water can determine the actual amount of chlorine present.

   b. Preparing Stock Solutions:

High-Test Calcium Hypochlorite			
PERCENTAGE SOLUTION	**OUNCES**	**GRAMS**	**TABLESPOON(S)**
0.25% stock solution in 1 gallon of water	0.5	15	1 heaping
2.00% stock solution in 1 gallon of water	3.8	118	½ cup or 8 heaping

Chlorine Dosage Calculator

PPM	1			5			25			50			100			200		
	Available Chlorine																	
Quantity (Gal) *	5%	10%	65 to 70%	5%	10%	65 to 70%	5%	10%	65 to 70%	5%	10%	65 to 70%	5%	10%	65 to 70%	5%	10%	65 to 70%
50,000	1 gal.	2 qt.	10 oz.	5 gal.	10 qt.	3 lb.	25 gal.	50 qt.	15 lb.	50 gal.	25 gal.	30 lb.	100 gal.	50 gal.	59 lb., 9 oz.	200 gal.	100 gal.	119 lb., 4 oz.
25,000	2 qt.	1 qt.	5 oz.	10 qt.	5 qt.	1 lb., 8 oz.	50 qt.	25 qt.	7 lb., 8 oz.	25 gal.	50 qt.	15 lb.	50 gal.	25 gal.	29 lb., 12 oz.	100 gal.	50 gal.	59 lb., 8 oz.
10,000	26 oz.	13 oz.	2 oz.	1 gal.	2 qt.	10 oz.	5 gal.	10 qt.	3 lb.	10 gal.	5 gal.	6 lb.	20 gal.	10 gal.	12 lb.	40 gal.	20 gal.	23 lb., 13 oz.
5,000	13 oz.	7 oz.	1 oz.	2 qt.	1 qt.	5 oz.	10 qt.	5 qt.	1 lb., 8 oz.	5 gal.	10 qt.	3 lb.	10 gal.	5 gal.	6 lb.	20 gal.	10 gal.	11 lb., 15 oz.
2,000	6 oz.	3 oz.		26 oz.	13 oz.	1 oz.	1 gal.	2 qt.	10 oz.	2 gal.	1 gal.	1 lb., 3 oz.	4 gal.	2 gal.	2 lb., 7 oz.	8 gal.	4 gal.	4 lb., 13 oz.
1,000	3 oz.	1½ oz.		13 oz.	7 oz.		2 qt.	1 qt.	5 oz.	1 gal.	2 qt.	10 oz.	2 gal.	1 gal.	1 lb., 4 oz.	4 gal.	2 gal.	2 lb., 7 oz.
500	2 oz.	1 oz.		7 oz.	4 oz.		1 qt.	1 pt.	3 oz.	2 qt.	1 qt.	5 oz.	1 gal.	2 qt.	10 oz.	2 gal.	1 gal.	1 lb., 3 oz.
200	1 T.	1.5 t.		3 oz.	2 oz.		13 oz.	7 oz.	1 oz.	26 oz.	13 oz.	2 oz.	1 qt., 20 oz.	26 oz.	4 oz.	3 qt., 7 oz.	1 qt., 20 oz.	8 oz.
100	2 t.	1 t.		2 oz.	1 oz.		7 oz.	4 oz.		13 oz.	7 oz.	1 oz.	13 oz.	7 oz.	1 oz.	1 qt., 20 oz.	26 oz.	4 oz.
50	1 t.			1 oz.	½ oz.		4 oz.	2 oz.		7 oz.	4 oz.		7 oz.	4 oz.		26 oz.	13 oz.	2 oz.
25				2 T.	2 t.		2 oz.	1 oz.		4 oz.	2 oz.		3 oz.	2 oz.		13 oz.	7 oz.	1 oz.
10					1 t.		1 oz.			3 T.			2 oz.	1 oz.		6 oz.	3 oz.	
5							1 T.			5 tsp.						3 oz.	2 oz.	

T. = Tablespoon
t. = teaspoon
* The 5% and 10% columns are liquid sodium hypochlorite with quantities shown in volume. The bottle label indicates the percentage of chlorine available. Apportion chlorine percentages other than 5 or 10%. The 65 to 75% column is granular calcium hypochlorite with quantities shown by **weight**.

References and Resources

This Enclosure is published as a guide to help Medical Department Representatives inspect and monitor shipboard potable water. When making recommendations, Medical and Engineering personnel can cite and quote Navy manuals, publications, and notices to support this Manual. Each Medical Department Representative should procure copies as needed for reference and guidance.

Full Manual

U.S. Environmental Protection Agency, Water Supply Division. "Cross-Connection Control Manual," EPA 570/9-89-007.

American Public Health Association (APHA), American Water Works Association (AWWA), and Water Pollution Control Federation(WPCF), *Standard Methods for the Examination of Water and Waste Water*, 19th Edition, published 1995. These organizations update this manual approximately every three to four years; always use the most current version.

Victor M. Ehlers, C.E., and Ernest Steel, C.E., *Municipal and Rural Sanitation*, 6th edition, McGraw-Hill Book Co., Inc., 1965.

Ben Freedman, M.D., M.P.H., *Sanitarian's Handbook, Theory and Administrative Practice for Environmental Health*, 4th edition, Peerless Publishing Company, 1977.

Specific to Chapter 1

Environmental and Preventive Medicine Unit (EPMU) 26240.5/2A (9-77), "Sample Collection and Bacteriological Analysis of Potable Water."

General Specifications for Ships of the U.S. Navy.

Vincent B. Lamoureux, *Guide to Ship Sanitation*, World Health Organization, Geneva, Switzerland.

Naval Ships' Technical Manual (NSTM), Vol. 1, Chapter 220, "Water Chemistry;" Vol. 2, "Test and Treatment."

NSTM, Vol. 3, Chapter 74, "Gas Free Engineering."

NSTM, Chapter 90, "Inspections, Tests, Records, and Reports."

NSTM, Chapter 505, "Piping Systems."

NSTM, Chapter 531, "Distilling Plants."

NSTM, Chapter 533, "Potable Water Systems."

NSTM, Chapter 631, "Preservation of Ships in Service."

NSTM, Chapter 670, "Stowage, Handling, and Disposal of Hazardous General Use Consumables."

NAVFACINST 11330.11 (series), "Backflow Preventers, Reduced Pressure Principle Type."

NAVMEDCOMINST 6240.1 (series), "Standards for Potable Water."

NAVSEA 048-LP-122-9010, "Technical Manual, Brominator."

NAVSHIPS 0900-016-000, "Manual for Cargo Tank Cleaning."

NAVSUP Publication 486, Vol.1, "Food Service Management."

OPNAVINST 5090.1 (series), "Environmental and Natural Resources Protection Manual."

U.S. Army Field Manual, "Field Hygiene and Sanitation (FM 21-10)."

U.S. Department of Health and Human Services (HHS), U.S. Public Health Service (PHS), and Centers for Disease Control and Prevention (CDC), "Vessel Sanitation Program Operations Manual."

U.S. Public Health Service (PHS) and Food and Drug Administration (FDA), "Acceptable Vessel Watering Points Interstate Conveyance Official Classification List."

<u>Specific to Chapter 2</u>

COMDTINST 5100.47 (series), Safety and Environmental Health Manual.

Public Law 93-523, Safe Drinking Water Act.

Title 29, Code of Federal Regulations (CFR), Part 1910, OSHA Safety and Health Standards.

40 CFR 141, National Primary Drinking Water Regulations, as amended.

40 CFR 143, National Secondary Drinking Water Regulations.

American National Standards Institute (ANSI). American Safety Requirements for Working in Tanks and Other Confined Spaces, Z117.1-1977.

American Water Works Association (AWWA). Emergency Planning for Water Utility Management, Manual M19.

AWWA. Standard for Deep Wells, No. A100-66.

AWWA. Standard for Disinfecting Water Mains, No. C-601-68.

AWWA. Standard for Inspecting and Repairing Steel Water Tanks, Stand Pipes, Reservoirs, and Elevated Tanks for Water Storage, No. D101-53 (R1979).

EPA. Handbook for Evaluating Water Bacteriological Laboratories, EPA-670/9-75-006.

EPA. The Manual of Individual Water Supply Systems, EPA-430/9-74-07.

EPA. Municipal Environmental Research Laboratory. Treatment Techniques for Controlling Trihalomethanes in Drinking Water, EPA-600/2 81-156.

National Academy of Sciences. *Drinking Water and Health*, Volumes 1 (1977) and 2 (1980).

Salvato, J.A. *Environmental Engineering and Sanitation*, 3rd edition, John Wiley and Sons, 1982.

White, G.C. *Handbook of Chlorination*, 3rd edition, Van Nostrand Reinhold Company, 1992.

Specific to Chapter 3

IDEXX Laboratories, Inc., "Colilert® Presence/Absence Test User Manual."

Millipore Corporation, "Field Procedure in Water Microbiology," Cat. No. Lab 3140/P.

Water-Related Organizations

American National Standards Institute (ANSI) 11 West 42nd Street New York, New York 10036	(212) 642-4900
American Public Health Association 1015 – 15th Street, N.W. Washington, D.C. 20005	(800) 645-5439
American Water Works Association (AWWA) 6666 West Quincy Avenue Denver, Colorado 80235	(800) 926-7337

Environmental Protection Agency (EPA) 401 M Street, S.W. Washington, D.C. 20460	(800) 426-4791

EPA Regional Offices

I.	2203 JFK Federal Building Boston, MA 02203	(617) 223-2226
II.	26 Federal Plaza, #900 New York, NY 10278	(212) 264-2516
III.	Curtis Building 6th and Walnut Streets Philadelphia, PA 19106	(215) 597-3420
IV.	345 Courtland Street, NE Atlanta, GA 30365	(404) 881-4450
V.	230 South Dearborn Street Chicago, IL 60604	(312) 353-2147
VI.	First International Building 1201 Elm Street Dallas, TX 75270	(214) 767-2656
VII.	324 East 11th Street Kansas City, MO 64106	(816) 374-5971
VIII.	900 Lincoln Tower 1860 Lincoln Street Denver, CO 80203	(303) 837-4871
IX.	215 Fremont Street San Francisco, CA 94105	(415) 556-0893
X.	1200 – 6th Avenue Seattle, WA 98101	(206) 442-1237

Federal Emergency Management Agency (FEMA) 500 C Street, S.W. Washington, D.C. 20472	(202) 898-6100

FEMA Regional Offices

I.	J.W. McCormack Post Office and Courthouse Bldg., Rm. 442 Boston, MA 02109	(617) 223-9540
II.	26 Federal Plaza, Rm. 1337 New York, NY 10278	(212) 225-7215
III.	Liberty Square Bldg., 2nd Fl. 105 South 7th Street Philadelphia, PA 19106	(215) 931-5750
IV.	1371 Peachtree St., N.E. Atlanta, GA 30309	(404) 853-4400
V.	175 West Jackson, 4th Fl. Chicago, IL 60604	(312) 408-5533
VI.	Federal Regional Center, Rm. 206 800 North Loop 288 Denton, TX 76201	(817) 898-5127
VII.	911 Walnut Street, Rm. 200 Kansas City, MO 64106	(816) 283-7002
VIII.	Denver Regional Center, Bldg. 710 Box 25267 Denver, CO 80225	(303) 235-4830
IX.	Presidio of San Francisco, Bldg. 105 San Francisco, CA 94129	(415) 923-7176
X.	Federal Regional Center 130 – 228th Street, S.W. Bothel, Washington 98021	(206) 487-4682

IDEXX Laboratories, Inc. One Idexx Drive Westbrook, Maine 04092	(207) 856-0303
Millipore Corporation 80 Ashby Road Bedford, Massachusetts 01730-2271	(800) 645-5476

National Academy of Sciences 2101 Constitution Avenue, N.W. Washington, D.C. 20418	(202) 334-2000
National Sanitation Foundation, International (NSF) P.O. Box 130140 3475 Plymouth Road Ann Arbor, Michigan 48113	(800) 673-6275
World Health Organization (WHO) 535 – 23rd Street, N.W. Washington, D.C. 20037	(202) 974-3000

Definitions

1. Activated Sludge. Sludge which, because of previous aeration or other treatment, is more biologically active than raw sewage sludge.

2. Aeration. The process of bringing air into intimate contact with sewage to oxidize organic material and promote the action of aerobic bacteria in digesting the sewage.

3. Aerobic Decomposition. The decay of sewage into components by organisms that require dissolved oxygen to live.

4. Aerobic Waste Treatment. Waste stabilization through the action of microorganisms in the presence of oxygen.

5. Airgap. A distance equal to twice the diameter of a supply pipe but at least one (1) inch, creating a physical separation sufficient to prevent backflow between the free-flowing discharge end of the potable water system and any other system.

6. Anaerobic Decomposition. The decay of sewage into components by organisms that do not require dissolved oxygen to live.

7. Anaerobic Waste Treatment. Waste stabilization through the action of microorganisms in the absence of air or elemental oxygen.

8. Aquifer. A permeable, water-bearing geologic formation.

9. Backflow. The flow of water or other liquids, mixtures, or substances into a potable water system's distribution pipes from any source(s) other than the intended source. One type of backflow is back siphonage; see Definition 11.

10. Backflow Preventer. A device or means designed to prevent backflow or back siphonage, most commonly an air gap, reduced pressure zone device, double check valve assembly, pressure vacuum breaker, atmosphere vacuum breaker, hose bib vacuum breaker, residential dual check, double check with intermediate atmosphere vent, and barometric loop.

11. Back Siphonage. Backflow resulting from negative pressures in a potable water system's distribution pipes.

12. Bacteria. One-celled microorganisms that live in soil, water, or organic matter.

13. Black Water. Human body wastes and wastes from toilets, urinals, soil drains, and receptacles intended to receive or retain body wastes. Also called sewage.

14. Biological Oxygen Demand (BOD). The amount of oxygen bacteria and other organisms require to stabilize (oxidize) the organic matter in a given amount of sewage.

15. Break-Point Chlorination. The application of chlorine to produce a residual of free available chlorine with little or no combined chlorine present.

16. Check Valve. A self-closing device designed to allow fluids to flow in one direction and close if the flow reverses.

17. Chemical Oxygen Demand (COD). The amount of oxygen required to oxidize all organic compounds in a given amount of sewage into carbon dioxide and water.

18. Chlorine Residual. Measured in milligrams per liter (mg/l) or parts per million (ppm), the amount of free chlorine remaining in sewage a specific length of time after the sewage and chlorine are mixed.

19. Chlorination. The process by which chlorine is added to sewage.

20. Coliform Bacteria. Bacteria indicating the presence of fecal contamination in water. These bacteria are easily detected by tests and are abundant in humans' and other vertebrates' large intestine and colon.

21. Colloids. Suspended particles that, because they are so small, do not settle.

22. Combined Available Chlorine. The chlorine products formed by the reaction of equilibrium products of ammonia and of chlorine to form chloramines. Combined available chlorine has significantly less disinfecting power than free available chlorine.

23. Comminutor. A motor-driven grinder that pulps or liquifies sewage solids before they enter a Marine Sanitation Device; see Definition 27.

24. Community Water System. A public water system that serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents. CG shore commands who own or operate a public water systems that serve housing/barracks may fit this category.

25. Contaminant. A substance that impairs water quality either by poisoning or spreading disease to the point the water becomes a serious public health hazard.

26. Contamination. The presence in water of potentially pathogenic organisms that make the water hazardous for human consumption or domestic use.

27. Contiguous Zone. Established by the U.S. under the Convention of the Territorial Sea and the Contiguous Zone, an area of the high seas contiguous to the Territorial Sea extending 9 nautical miles (nm) seaward from the outer limit of the Territorial Sea, thus extending a total of 12 NM offshore; see Definition 61.

28. Cross-Connection. Any actual or potential connection between the potable water supply and a source of contamination or pollution.

29. Crossover Point. Any point or points where a potable water main makes contact with or crosses over or under a non-potable liquid conduit, e.g., sewer, non-potable water supply.

30. Dessicator. A closed container used in a laboratory to maintain a dry atmosphere. A dessicator usually has two compartments, one containing a chemical (dessicant) that absorbs the moisture from the air in the other compartment.

31. Disinfection. The act of inactivating the vast majority of microorganisms in or on a surface with the probability the agent used will kill all pathogenic bacteria present.

32. Effluent. Wastewater or other liquid, partially or completely treated or in its natural state, flowing out of a reservoir, basin, sewage treatment plant, industrial plant, or marine sanitation device.

33. EPA. The abbreviation for the United States Environmental Protection Agency. EPA's missions are to protect human health and safeguard the natural environment.

34. Facultative Anaerobic Bacteria. Bacteria that adapt to grow in either the presence or absence of oxygen.

35. Field Water Supply System. That assembly of collection, purification, storage, transportation, and distribution equipment and personnel to provide potable water to field units in training and actual deployment.

36. Finished Water. Treated water.

37. Fixed Installation. An installation that through extended use has gained those structures and facilities, e.g., paved roads, fixed electrical distribution systems, fixed water treatment facilities, and underground distribution lines, so well-built or -repaired they have become permanent.

38. Floc. A fluffy mass formed by the aggregation of a number of finely suspended particles, a process called flocculation. In sewage treatment, chemical or bacterial action forms floc to remove finely suspended solids from sewage.

39. Flood-Level Rim. The edge of the receptacle from which water overflows.

40. Free Available Chlorine. Chlorine available in the forms of hypochlorous acid and hypochlorite ions after chlorine demand has been satisfied.

41. Gray Water. Ship-generated wastewater originating from cooking, bathing, laundering, deck drains, and other waste drains.

42. Health Hazard. Any condition, including any device or water treatment practice, that may adversely affect a person's well-being.

43. Influent. The liquid flowing into a sewage treatment system or one of its compartments.

44. Inland Waters. Generally navigable fresh or brackish waters upstream from coastal territorial waters.

45. Marginal Chlorination. Application of chlorine to produce the desired total chlorine residual without referring to the amounts of free or combined chlorine present.

46. Marine Sanitation Device (MSD). Any equipment on board a ship or craft designed to receive and treat sewage to a level acceptable for overboard discharge or that receives and retains sewage on board for later discharge ashore or in waters where discharge is permitted. The Coast Guard uses the generic term "MSD" to identify these general types:

   a. Type I. A "flow-through and discharge" device designed to receive and treat sewage aboard ship and produce an overboard effluent with a maximum fecal coliform count of 1,000 per 100 milliliters and no visible solids.

   b. Type II. A "flow-through and discharge" device producing an overboard effluent with a maximum fecal coliform count of 200 per 100 ml and maximum total suspended solids of 150 milligrams per liter, e.g., the Pall Trinity Biological Waste Treatment System.

   c. Type III-A. A "non-flow-through" device designed to collect shipboard sewage by vacuum or other reduced-flush systems and hold sewage while transiting navigable waters. This type may include equipment to evaporate or incinerate collected sewage aboard ship, e.g., the GATX Evaporative Toilet System, Jered Vacu-Burn Treatment System, and Koehler-Dayton Recirculating Flush System.

   d. Type III-B. A collecting, holding, and transferring (CHT) system designed to collect both sewage and gray water while in port; offload sewage and gray water to suitable shore receiving facilities; hold sewage while transiting navigable waters; and discharge overboard both sewage and gray water when operating beyond navigable waters. The CHT system consists of collection and discharge piping, pumps, comminutors (or strainers), an aeration system, and holding tanks.

47. Maximum Contaminant Level. The maximum permissible amount of a contaminant in water delivered to the free-flowing outlet of a public water system's ultimate user, except for turbidity, whose maximum permissible amount is measured at the point of entry to the

distribution system. This definition excludes substances a user adds to the water under controlled circumstances.

48. Medical Bacteriological Sampling. Independent bacteriological sampling of the water distribution system conducted by the Medical Department to augment sampling required by National Primary Drinking Water Requirements (NPDWR).

49. Medical Department Representative (MDR). In units with assigned clinic personnel, the Preventive Medicine Technician (PMT) or Independent Duty Technician (IDT); in other units, the Medical Department Representative is the Executive or Executive Petty Officer.

50. Must. Indicates a requirement necessary or essential to meet current accepted standards of protection as directed by Federal rules and regulations.

51. Navigable Waters of the United States. The United States' coastal territorial waters (sea), inland waters, including the United States portion of the Great Lakes, and the St. Lawrence Seaway.

52. Non-Community Water System. A public water system that is not a community water system. CG shore commands who own or operate a public water system without housing/barracks may fit this catgory.

53. Non-Potable Water. Water proper authorities have not examined, properly treated, or approved as being safe for domestic consumption. Assume all waters are non-potable until proved potable.

54. Oxidation. The addition of oxygen to break down organic waste and chemicals in sewage by bacteriological and chemical means.

55. Palatable Water. Water pleasing to the taste and appearance and significantly free of color, turbidity, and odor, with neutral or attractive aesthetic or sensory qualities. Does not imply potability.

56. Potable Water. Water responsible installation medical authorities have examined and/or treated to meet appropriate standards and declared safe for human consumption.

57. Primacy. Primary enforcement authority. Under the Safe Drinking Water Act the EPA Administrator delegates primary enforcement authority to a state government provided it has established drinking water regulations at least as stringent as the present NPDWR.

58. Public Water System. A system that provides piped water for human consumption to at least 15 service connections or regularly serves an average of at least 25 persons daily at least 60 days out of the year. This term includes:

   a. Any collection, treatment, storage, or distribution facility under its operator's control and used primarily in connection with such system.

b. Any collection or pre-treatment storage facilities not under such control but used primarily in connection with such system. A public water system is either a "community water system" (Definition 24) or a "non-community water system" (Definition 52).

Note: Final interpretation of whether or not water system is a public water system rests with the state/EPA.

59. Raw Water.

a. Untreated water, usually the water entering a water treatment plant's first treatment unit.

b. Water used as a water supply source from a natural or impounded body of water, e.g., a stream, lake, pond, or ground water aquifer.

60. Reduced Pressure Zone (RPZ) Backflow Preventer. An assembly of differential valves and check valves including an automatically opened spillage port to the atmosphere designed to prevent backflow.

61. Restricted Zone. The navigable waters of the United States 0 to 3 nautical miles from shore.

62. Sanitary Defects. Conditions that may contaminate a water supply during or after treatment, including connections to unsafe water supplies, raw water bypasses in treatment plants, improperly designed and installed plumbing fixtures, and leaking water and sewer pipes in the same trench.

63. Sanitary Survey. An on-site review of a public water system's water source, facilities, equipment, operation, and maintenance to evaluate their adequacy to produce and distribute safe drinking water.

64. Sewage. In shipboard applications, wastes of human origin from water closets and urinals transported by the ship's soil drain system. Also called black water. In shore-based treatment applications, "sewage" may include black water and other wastewater.

65. Should. Indicates an advisory recommendation applied when practical.

66. Soil Drains. Drains that collect sewage from toilets and urinals.

67. Spring. A concentrated discharge of ground water appearing on the ground surface.

68. Standard Sample. The aliquot (100 ml) of finished drinking water examined for the presence of coliform bacteria.

69. Superchlorination. The application of chlorine in dosages far exceeding the chlorine demand for disinfection.

70. Territorial Sea. The belt of the seas measured from the line of ordinary low water along that portion of the coast in direct contact with the open sea and the line marking the seaward limit of inland waters, extending seaward a distance of 3 nautical miles.

71. Total Available Chlorine. The sum of the chlorine forms present as free available chlorine and combined available chlorine.

72. Treated Water. Water that has undergone processing, e.g., sedimentation, filtration, softening, disinfection, etc., and is ready for consumption, including treated (chlorinated, fluoridated, etc.) purchased potable water.

73. Trihalomethanes (THMs). A class of organic compounds commonly found in chlorinated or brominated drinking water formed by the reaction of naturally occurring organic substances (commonly called precursors) with chlorine or bromine during water treatment operations and distribution. The four organic halogen compounds that make up total trihalomethanes are: Trichloromethane (chloroform), bromodichloromethane, dibromochloromethane and tribromomethane (bromoform).

74. Vacuum Breaker, Non-Pressure Type. A device or means to prevent backflow designed not to be subjected to static line pressure.

75. Vacuum Breaker, Pressure Type. A device or means to prevent backflow designed to operate under conditions of static line pressure.

76. Wastewater. The spent water of a ship, base, industrial plant, or other activity. The source may combine the liquid and water-carried wastes from soil and ships', industrial plants', housing areas', and institutions' waste drains together with any groundwater, surface water, or storm water that may be present.

77. Waste Drains. Drains that collect wastewater (gray water) from showers, laundries, and galleys, etc.

78. Water Quality. The chemical, physical, radiological, and microbiological characteristics of water with respect to its suitability for a particular purpose.

79. Water Supplier. Any person who or entity that owns or operates a public water system.